Official Organ of the American Welding Society

The Welding Engineer

Edited by L. B. Mackenzie

$3.00 per year in U. S. | Reg. U. S. Pat. Office | $4.00 per year abroad

Vol. 6 | Chicago 608 S Dearborn St. | APRIL, 1921 | New York 171 Madison Ave. | No. 4

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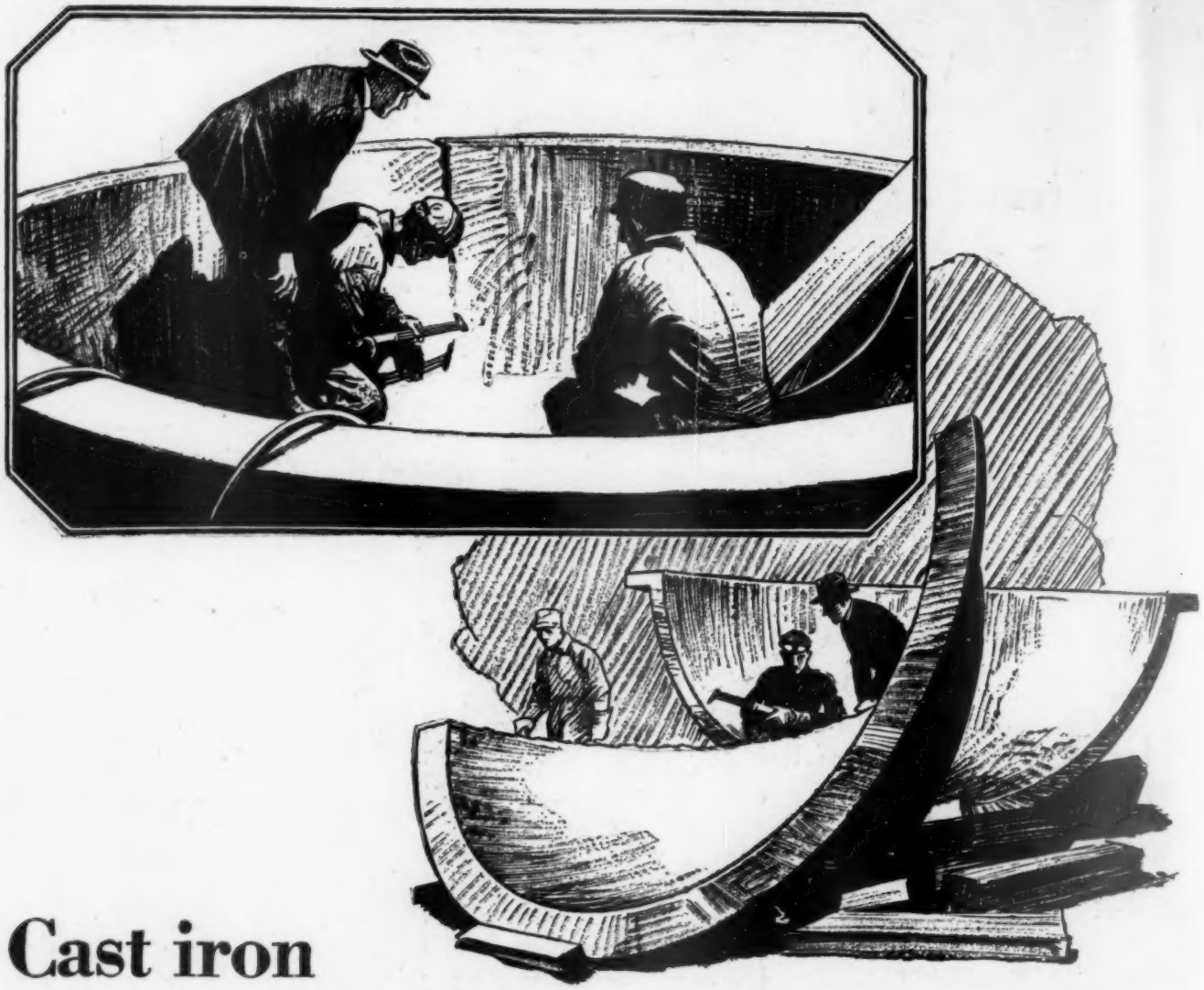
Published Monthly by the Welding Engineer Publishing Co. Entered as Second Class Matter Jan. 20, 1916, at the Post Office at Chicago, Ill., Under the Act of March 3, 1879.



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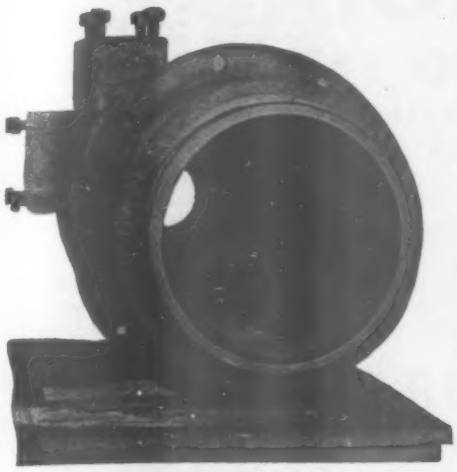

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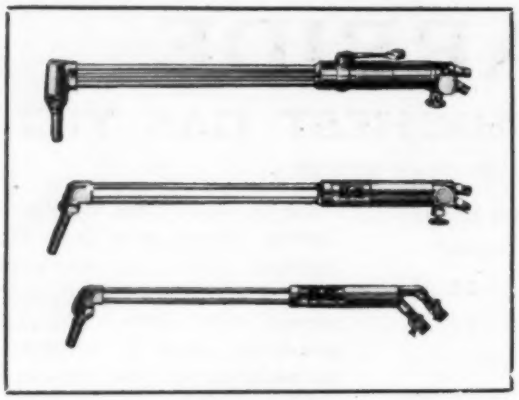

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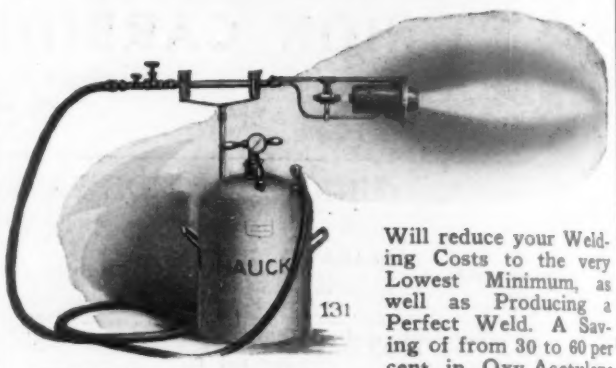

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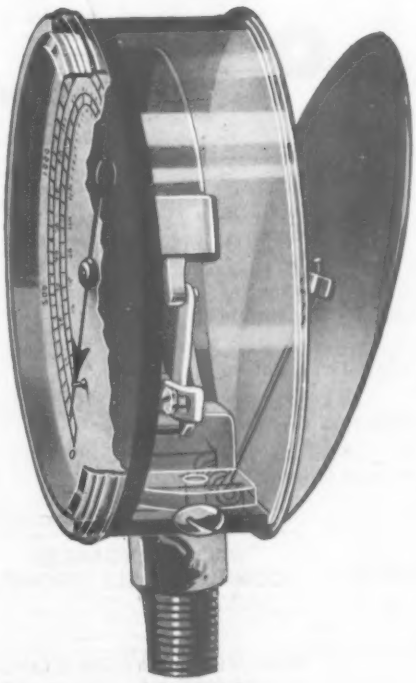

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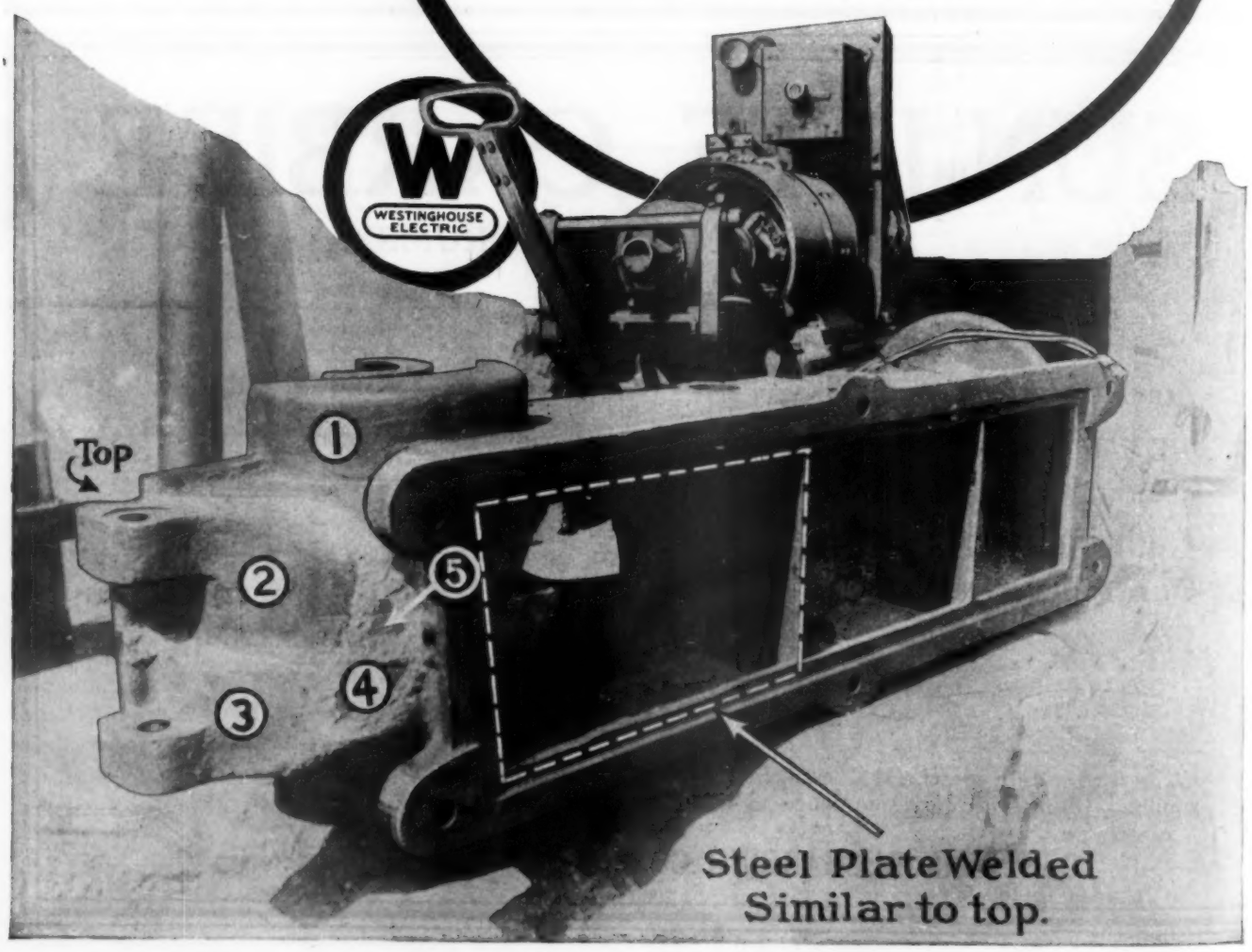

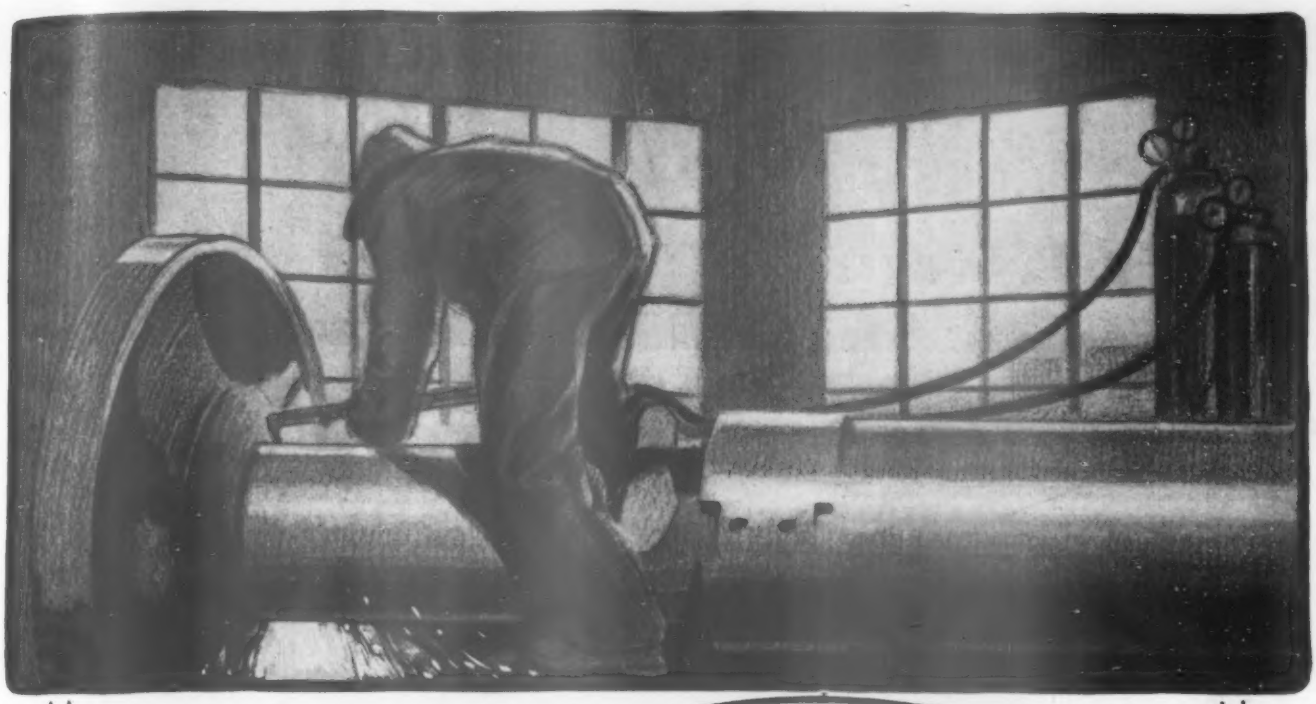

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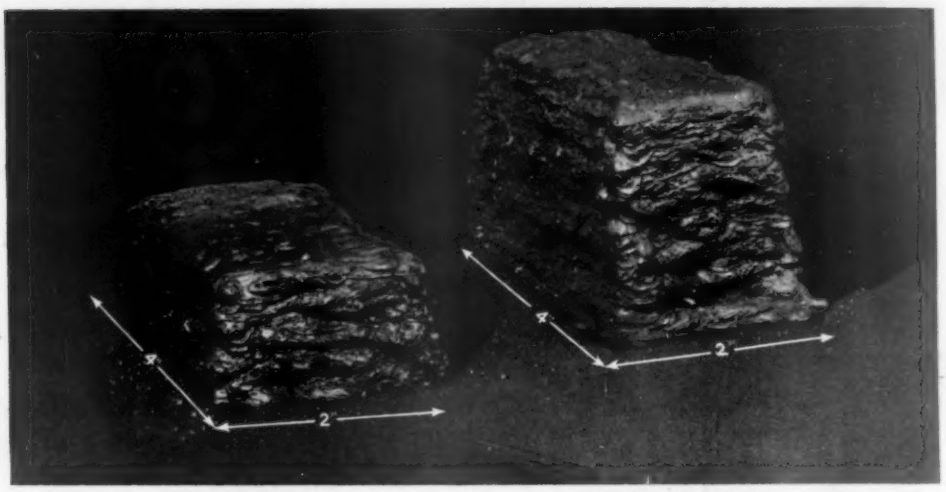

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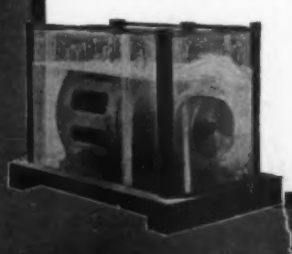

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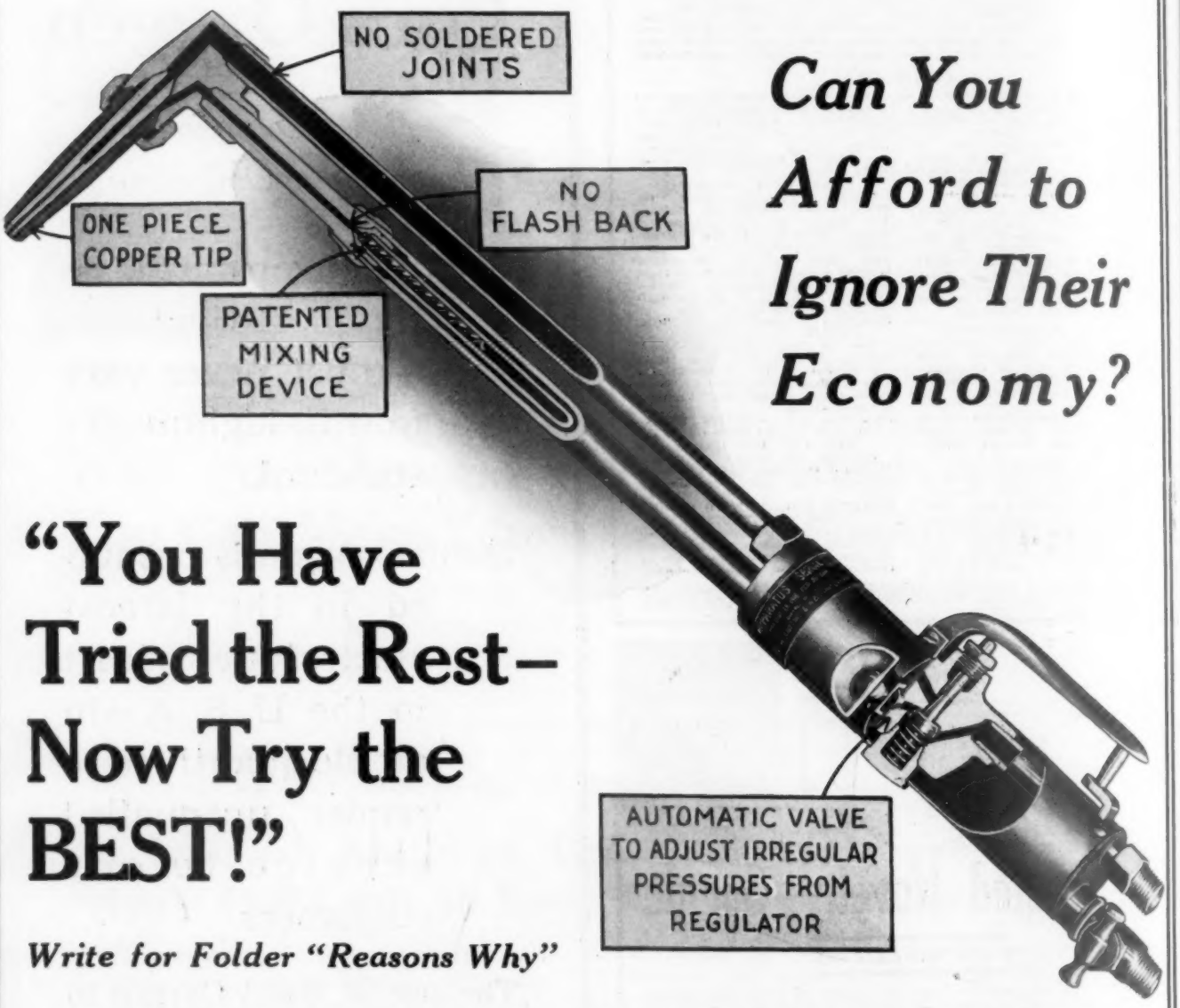
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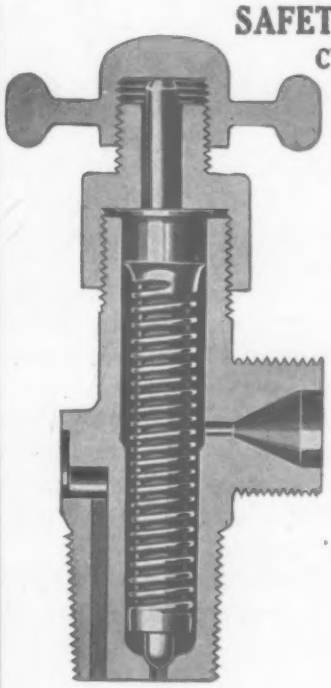

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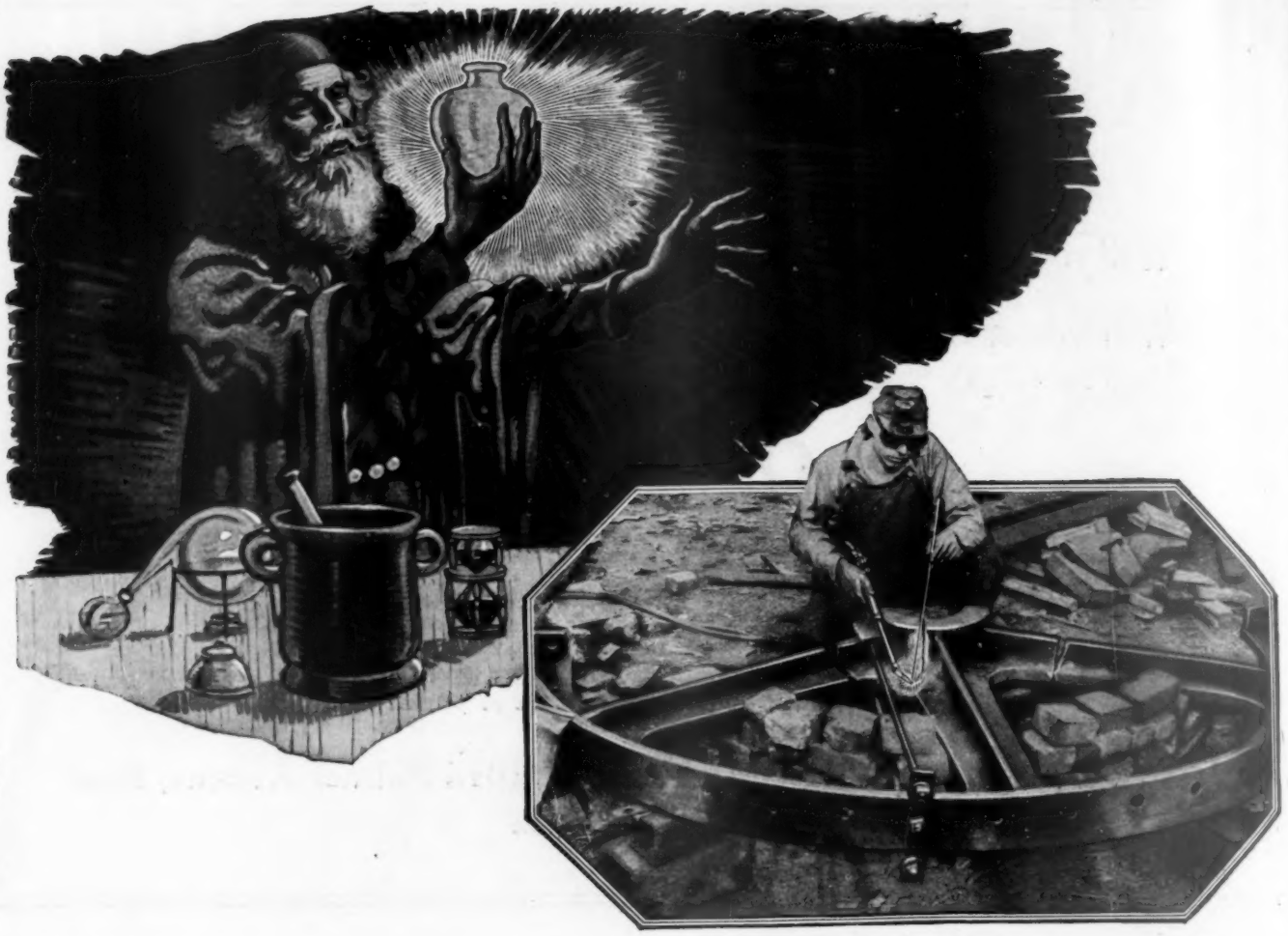

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EFFECT OF HEAT TREATMENT ON NITRIDE IN METAL ARC WELDS**

By James W. Owens *, J. H. Ramage † and J. A. Watts ‡

AMONG other metallographic features peculiar to all metal arc welds of iron and steel, made in air, the needle-like lines in the micro-photograph, Fig. 1, are perhaps the most outstanding and distinctive.

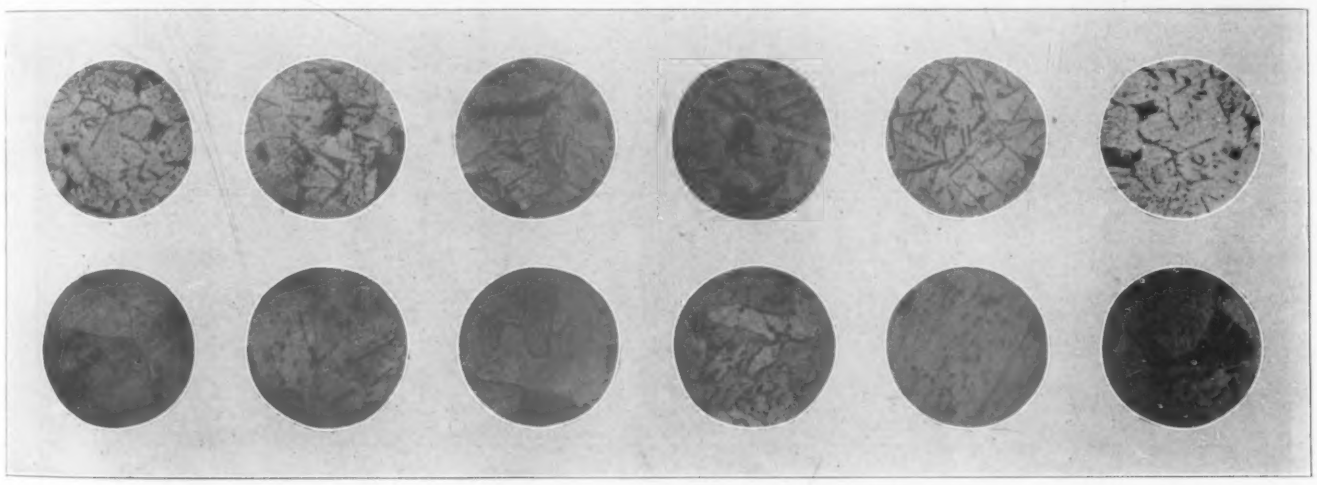
Considerable discussion has taken place and difference of opinion exists as to the composition and cause of these needles. They have been called strain lines, twining lines, martensite, carbide and nitride by various investigators, but it is now almost unanimously agreed that the needles are an indication of the presence of nitrogen in the metal, probably in the form of iron nitride.

Similar lines have been found in pure iron which had been nitrogenized by heating in an atmosphere of ammonia gas, by Strauss, Ruder and others. These investigators also found several other forms of nitride in the iron which they attribute to varying amounts of nitrogen.

Experimental work by the authors at the Norfolk Navy Yard indicates that the heat treatment to which the deposited metal has been subjected determines the form of the nitride in the metal, and that the form in which the nitride exists has a very decided effect upon the physical properties of the metal. The presence of nitride, as well as the exceptionally large amount of oxide found in the deposited metal, may be explained as follows:

The electrode material, in passing through the arc, either in the molten or vaporous state, encounters an atmosphere of nascent oxygen and nitrogen formed in the arc by the breaking down of the molecular structure of these constituents of the air.

Nitrogen, although ordinary very inactive, is, at this high temperature and in the nascent or mon-atomic state, very active, and immediately combines with the iron. The longer the air gap through which the metal passes, the greater will be the nitrogen content in the deposit. This is evidenced by the greater number of needles and pearlitic-like nitride found in welds made with a long arc, as well as the weakness of these welds, Figs. 2 and 3. If it were possible to entirely exclude the air from the metal in the arc



Top, Left to Right, Figures 1 to 6; Bottom, Left to Right, Figures 7 to 12.

1. Normal Amount of Oxygen and Nitrogen.—2. Showing Nitride Euctectic.—3. Showing Extra Large Nitride Needle. (2 and 3 Show Large Amount of Oxygen and Nitrogen Produced by Long Arc.)—4. Columnar Grain Structure Produced by Chilling.—5. After Annealing. Showing Needles and Oxide Spots as in Fig. 6, but Pearlitic-Like Areas Have Disappeared.—6. As Deposited.—7. After Quenching. Showing Structure Similar to Pure Metal. Nitrides Have Disappeared but Oxide Spots Still Present.—8. Specimen in Fig. 7 Re-heated to 2000° F. and Cooled in Furnace. Needles Reappear but Fewer in Number.—9. Quenched at 950° F. Showing Nitride Dissolved in Ferrite Causing Critical Point, Also Curly Grain Structure and Darkening Some Grains to a Brownish Shade.—10. Quenched at 850° F. Needles Begin to Form.—11. Pearlitic and Needle-like Form when Quenched at 775° F.—12. Pearlitic-like Form at Higher Magnification.

**Paper presented before the Metropolitan Section of the American Welding Society, Engineering Building, New York City, February 24, 1921.*

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during the welding operation, the ductility of the deposit would be greatly increased.

When made with a mild steel or ingot iron electrode, the deposit is almost carbonless iron. Iron in its pure state would be very ductile and fairly strong, but in the weld is comparatively weak and very brittle, owing to its strained, large and columnar grain structure, Fig. 4, and large content of oxide and nitride or iron, besides such mechanical defects as slag inclusions and blow holes, Fig. 1.

In our investigations welds were made under varying conditions, and subjected to a variety of cooling treatments. Upon examining some very rapidly chilled welds, no needle-like structure at all was apparent, although made from the same electrode material and in the same manner as other welds, except for this chilling, etc. This indicated either that there was no nitrogen in these welds or that it was present but the pearlitic-like areas had disappeared.

After violent quenching the structure is seen to be very much different from either the material as deposited or after annealing. The oxide spots were still present, but aside from these, the only other features were the grain boundaries, just as in pure metal and solid solutions.

The rings were now turned to the correct size for tensile and ductility tests in the Owens testing apparatus. The chips from rings 1 to 6, inclusive, were sent to the Bureau of Standards for determination of the nitrogen present as nitride.

The data collected on the physical properties of these rings is given in Table 1:

It appeared from a study of the micro-structure and the data obtained that at some temperature between atmospheric and 2,250 deg. F. the nitrides are dissolved in the ferrite just as the carbides are, and that in this condition of solid

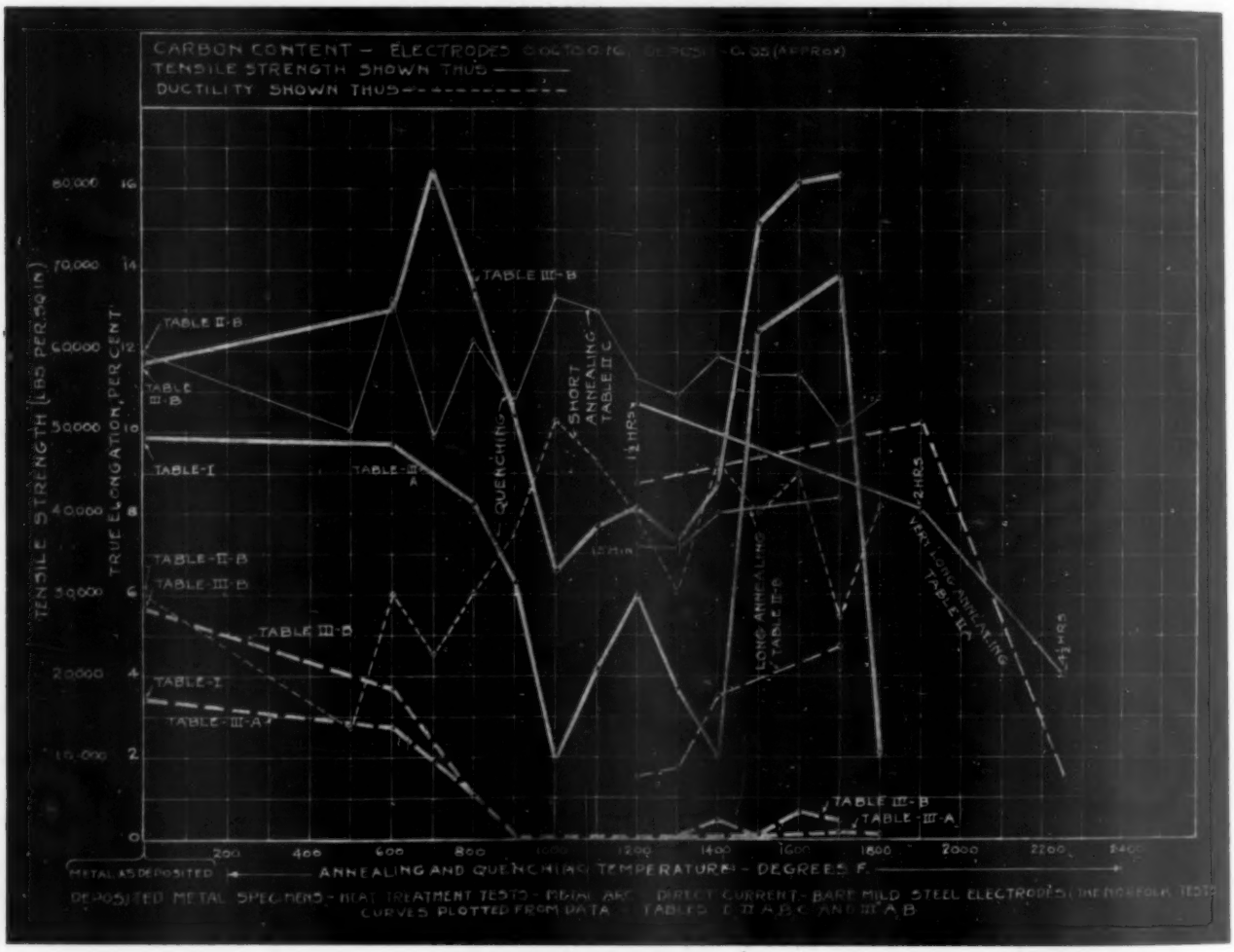


Fig. 17. Chart of Tensile Strength and Ductility of Specimens.

dissolved in the ferrite. Thiis suggested a line of research into this subject, the results of which follow.

Effect of Heat Treatment Upon Nitride in Welds.

A bar made entirely of deposited material was prepared, from which seven test rings were cut and numbered consecutively 1 to 7. Rings Nos. 3, 4, 5, and 6 were heated to 2,250 deg. F. for about three hours. Nos. 3 and 4 were allowed to cool in furnace, while Nos. 5 and 6 were removed and quenched in ice water. The structure of the metal as deposited, after annealing and after quenching is shown in micro-photographs, Figs. 1, 5 and 7, respectively.

As deposited, the metal shows the characteristic features of metal arc welds, namely, oxide spots, nitride needles and pearlitic-like nitride.

After annealing the metal had the same features as the ordinary deposited metal, showing needles and oxide spots, solution the nitrogen renders the iron extremely brittle, without, however, affecting its hardness. The nitrogen at least that present as nitride, is also reduced in amount by subjecting the metal to long heating at some temperature below 2,250 deg. F. Upon slow cooling through this critical range the needles are again ultimately formed, but are fewer in number, due to the loss of nitride, and the metal regains some ductility. The carbon present was less than .05 per cent as determined by repeatedly checked analyses, and would not account entirely for the pearlitic-like areas which are assumed to be another form of the nitride, possibly together with some carbide.

No conclusion as to the strength of the deposited metal can be reached from the foregoing and no fair comparison can be made of strength and ductility before and after annealing, as the metal was soaked for a long time, as noted at a temperature far above its recrystallization point, causing

TABLE I

EFFECT OF NITRIDE ON TENSILE STRENGTH, DUCTILITY AND HARDNESS

Specimen number	Treatment	Ultimate strength		Elongation		Per cent	Scleroscopic hardness	
		In lbs.	In lbs. per sq. in.	In inches (circumferential)	In per cent (of 3½ in.)	nitrogen as nitride	Each specimen	Average
1	As deposited	3,990	46,500	0.075	3.	0.142	21.6	.....
2	As deposited	4,450	52,000	0.090	3.75	0.141	22.2	21.9
5	Heated to 2,250° F. for 3 hours, and quenched in ice water	1,800	19,500	0.030	1.25	0.041	14.0	15.1
4	Heated to 2,250° F. for 3 hours, and allowed to cool in furnace	1,950	20,000	0.035	1.50	0.038	16.2	.....
5	Heated to 2,250° F. for 3 hours, and quenched in ice water	1,570	16,000	0.000	.0	0.051	18.0	19.0
6	Heated to 2,250° F. for 3 hours, and quenched in ice water	1,880	19,000	0.000	.0	0.048	20.0	.....
7	Heated to 1,200° F. for 15 minutes, and allowed to cool in furnace	4,470	54,000	0.210	8.75	.....	.....	.....

Remarks*: Each layer of deposit cleaned with brush only.

tremendous grain growth, as shown in microphotograph, Fig. 5, and hardness tests.

Ring No. 7 was now heated for a short time (approximately 15 min.) at 1,200 deg. F., and allowed to cool with the furnace, with results as noted, in Table 1.

These results have been repeatedly checked since and always show that slow cooling from the proper temperature increases the ductility of the deposited metal. This would indicate that the rate of cooling of the weld in air as occurs in ordinary practice is too rapid to permit all of the embrittling dissolved nitride coming out of solution.

The quenched samples, showing no needles, Fig 7, were reheated to about 2,000 deg, F., and slowly cooled for further proof that the nitride was still in them, Fig 8. This micro-photograph is typical of the structure of these specimens which again show the needle structure, the needles, however, being fewer in number.

An attempt was made to determine the critical points with a transformation point recorder, but only two very faint points were found in all samples at approximately 1,400 deg. F. and 1,580 deg. F., both undoubtedly iron or very low steel points. No attempts were made to carry the cooling below 1,000 deg. F.

Determination of Temperature at Which Nitride Changes Take Place and Corresponding Structural Changes

In order to determine by microscopic examination and physical tests where this change in nitride and ductility took place a large number of rings of deposited material were prepared. The carbon content of this material was below .06 per cent and the rings were subjected to various heat treatments, photographed and tested. The results of these tests are tabulated in Tables II-A, II-B, III-A, and III-B.

An average tensile strength and ductility of rings as deposited is 58,166 lb. per square inch, with 5¾ per cent elongation in 3½ inches, Table III-B.

While the few tests run in the short period devoted to this work are not sufficient to establish beyond doubt all of the phenomena of the nitride changes in iron, the following conclusions seem to be well founded:

At some temperature between 800 and 1,000 degrees Fahrenheit, the nitrogen in the iron as iron-nitride is dissolved in the ferrite, Fig. 9, giving rise to a critical point. The ferrite containing dissolved nitrides is rendered very brittle, losing practically all of its ductility. This is clearly shown in curves, Fig. 17. With slow cooling back through this range, the nitride comes out of solution and ultimately assumes either the needle-like form, Figs. 1 and 5, or the pearlitic-like from, Fig. 12. It is yet undetermined which is the ultimate state of equilibrium at low temperature. With the nitride no longer in solid solution, the ferrite regains the ductility. The transition is not rapid, requiring quite a long period of time at or near this range.

The nitride seems to cause several structural changes in the metal during the transition, first a sort of a curly grain structure, Fig. 9, then a darkening of some of the grains to a brownish shade, shown in the same figure, then possibly a coagulation of the nitride in the pearlitic-like areas, Figs. 11 and 12, and finally the needles, assuming that the needles

TABLE II

EFFECT OF ANNEALING ON TENSILE STRENGTH AND DUCTILITY

Remarks—(a) Temperature of furnace was gradually reduced and each specimen put in at temperature given, and maintained at this temperature for time specified. (b) A specimen or specimens once put in, remained in furnace until cold.

A—Very long annealing (each layer cleaned with brush only)

Specimen number	Temperature in degrees F.	Time specimen was held at temperature specified	Ultimate Strength: In lbs.	Ultimate Strength: In lbs. per sq. in.	Elongation: In inches (circumferential)	Elongation: In per cent of 3½ in. (true)
5a	2,250	4½ hrs.	1,880	19,000	.030	1.25
6a	2,250	4½ hrs.	1,950	20,000	.035	1.50
H20	1,900	2 hrs.	3,360	38,500	.221	9.25
H27	1,900	2 hrs.	3,500	40,500	.245	10.25
7a	1,200	1½ hrs.	4,575	53,750	.210	8.75

B—Long annealing (each layer cleaned with brush only)

19	1,700	10 min.	3,640	42,000	.125	4.75
16	1,400	15 min.	3,470	40,000	.085	3.50
17	1,300	15 min.	3,110	36,000	.045	1.75
18	1,200	15 min.	3,100	36,000	.040	1.50

C—Short annealing (each layer of deposit cleaned with brush)

Remarks—(a) Specimens specially deposited for test given. (b) Three separate tests, A, B, C. (c) Averages used for plotting curves.

Specimen number	Test number	Annealing temperature in degrees F.	Ultimate Strength: In lbs.	Ultimate Strength: In lbs. per sq. in.	Elongation: In inches (circumferential)	Elongation: In per cent of 3½ in. (true)
1-a	1	1,800	4,860	57,000	0.275	11.5
1-b	2	1,800	Poor specimen		.....	.....
1-c	3	1,800	4,430	52,000	.12	5.0
Average	....	.....	4,645	54,500	.197	8.25
2-a	1	1,700	3,890	45,000	.098	4.0
2-b	2	1,700	Poor specimen		.....	.....
2-c	3	1,700	4,750	56,000	.17	7.0
Average	....	.....	4,320	50,500	.134	5.5
3-a	1	1,600	4,860	57,000	.175	7.0
3-b	2	1,600	4,070	47,500	.16	6.75
3-c	3	1,600	5,930	67,500	.32	13.25
Average	....	.....	4,950	57,330	.218	9.0
4-a	1	1,500	5,060	59,500	.180	7.5
4-b	2	1,500	4,220	49,500	.1	4.0
4-c	3	1,500	5,460	63,000	.30	12.5
Average	....	.....	4,910	57,330	.193	8.00
5-a	1	1,400	4,160	48,500	.130	5.5
5-b	2	1,400	5,010	59,000	.22	9.25
5-c	3	1,400	6,330	71,200	.33	13.25
Average	....	.....	5,160	59,560	.226	9.33
6-a	1	1,300	4,270	47,740	.07	2.73
6-b	2	1,300	4,020	47,000	.065	2.75
6-c	3	1,300	6,200	70,000	.31	13.0
Average	....	.....	3,830	54,900	.148	6.16
7-a	1	1,200	5,380	62,500	.11	4.5
7-b	2	1,200	4,160	40,750	.17	7.0
7-c	3	1,200	5,070	59,750	.30	12.5
Average	....	.....	4,870	56,910	.193	8.0
8-a	1	1,100	6,530	73,000	.22	9.25
8-b	2	1,100	5,350	62,500	.195	8.0
8-c	3	1,100	5,070	59,750	.26	10.75
Average	....	.....	5,650	65,080	.225	9.33
9-a	1	1,000	5,680	65,000	.13	5.5
9-b	2	1,000	Poor specimen		.....	.....
9-c	3	1,000	6,080	68,750	.36	15.0
Average	....	.....	5,880	66,875	.245	10.25
10-a	1	900	4,230	49,500	.055	2.25
10-b	2	900	4,580	53,750	.2	8.25
10-c	3	900	5,010	59,000	.28	11.75
Average	....	.....	4,600	54,080	.34	7.50
11-a	1	800	7,230	78,000	.15	6.25
11-b	2	800	4,070	47,750	.076	3.0
11-c	3	800	5,010	59,000	.21	8.75
Average	....	.....	5,436	61,580	.145	6.0
12-a	1	700	3,835	44,500	.01	0.25
12-b	2	700	4,830	57,000	.12	5.0
12-c	3	700	4,930	58,250	.19	8.0
Average	....	.....	4,531	49,910	.106	4.50
13-a	1	600	6,770	74,500	.11	4.5
13-b	2	600	4,640	70,625	.105	4.25
13-c	3	600	5,850	66,750	.215	9.0
Average	....	.....	6,198	62,250	.146	6.00
14-a	1	500	4,450	52,000	.038	1.5
14-b	2	500	4,200	49,000	.051	2.0
14-c	3	500	4,260	50,000	.09	3.75
Average	....	.....	4,303	50,300	.327	2.75
			Material as deposited			
15-a	1	.....	5,458	54,000	.062	2.5
15-b	2	.....	5,370	62,000	.150	6.25
15-c	3	.....	5,400	62,500	.22	9.26
Average	....	.....	.....	59,500	.....	6.0

The ultimate strength curves of the quenched specimens, Fig. 17, also clearly shows the effect of the recrystallization

are the ultimate form. The needles appear to have no effect upon the ductility or strength of the ferrite, acting merely as

TABLE III

EFFECT OF QUENCHING ON TENSILE STRENGTH AND DUCTILITY

Remarks—(a) Specimens heated to temperature given and quenched in ice water at temperature specified. (b) Specimens "A" quenched at a lower temperature than that to which heated, while specimens "B" were quenched at the same temperature to which heated.

Specimen number	Time in furnace	Temperature in degrees F. to which heated	Quenching temperature in degrees F.	Ultimate strength: In lbs.	Ultimate strength: In lbs. per sq. in.	Elongation: In inches (circumferential)	Elongation: In per cent of 3½ in. (true)
A—Each layer of deposit cleaned with brush only							
A-4	4½ hrs.	2,250	2,250	1,740	18,390	.000	.000
B-4	2 hrs.	1,900	1,800	1,070	10,540	.000	.000
B-20	2 hrs.	1,900	1,700	6,140	69,500	.007	.020
B-14	2 hrs.	1,900	1,500	5,380	62,500	.004	.011
4	15 min.	1,900	1,400	1,020	10,000	.000	.000
5	15 min.	1,300	1,300	2,000	18,500	.0005	.001
6	15 min.	1,200	1,200	2,680	30,000	.002	.005
F	15 min.	1,100	1,100	2,010	21,000	.000	.000
E	15 min.	1,000	1,000	1,000	9,486	.000	.000
D	15 min.	900	900	2,780	31,500	.003	.008
C	15 min.	800	800	3,570	41,300	.020	.75
A	15 min.	600	600	4,170	48,500	.065	2.75
B—Each layer of deposit cleaned with pneumatic roughing tool							
A	5 min.	1,700	1,700	7,790	82,000	.014	.5
B	5 min.	1,600	1,600	7,710	81,000	.018	.75
C	5 min.	1,500	1,500	7,000	76,250	.000	.0
D	5 min.	1,400	1,400	3,780	44,000	.015	.5
E	5 min.	1,300	1,300	3,200	37,000	.001	.0
F	5 min.	1,200	1,200	3,500	40,500	.000	.0
G	5 min.	1,100	1,100	3,330	38,250	.000	.0
H	5 min.	1,000	1,000	2,910	33,000	.000	.0
J	5 min.	900	900	4,460	52,000	.000	.0
J	5 min.	800	800	5,920	67,500	.025	1.0
K	5 min.	700	700	7,910	82,750	.062	2.75
L	5 min.	600	600	5,720	65,500	.09	3.75
			Material as deposited				
1	.....	.....	.....	5,090	60,000	.145	6.0
2	.....	.....	.....	5,140	60,500	.178	7.5
3	.....	.....	.....	4,600	54,000	.092	3.75
Average	.....	.....	.....	.....	58,166	.....	5.75

*Presented before the American Institute of Mining Engineers, New York, February, 1919.

a mechanical inclusion. Mr. S. W. Miller mentions this in his paper on "The Path of Rupture in Steel Fusion Welds."* The metal also appears to drop off considerably in tensile strength during the transition stage, again regaining it after completion of the solid solution.

point in the vicinity of 1,500, to 1,700 deg. F., indicating that this new critical range is entirely distinct from that in which the recrystallization and carbon changes take place, as also do the critical points found and previously mentioned.

The foregoing indicates that the nitride, although a very important source of brittleness, may be reduced by slow cooling from above 1,000 deg. F. There will always, however, exist an extremely weak and brittle point at or near 1,000 deg. F. and metal arc welds cannot, with safety, be subjected to stresses when near this temperature until a method of preventing nitrogenization and oxidation during welding is developed.

The curves, Fig 17, show the effect of short, long and very long annealing, also quenching and metal as deposited.

It is proposed to check up these results by further research.

Figs. 13, 14, 15, and 16 show Test Specimens used in the test. Note the difference in Ductility between the Base and Deposited Metal Specimens.

Discussion of this paper by S. W. Miller, H. S. Rawdon, James W. Owens, J. A. Watts and J. H. Ramage will appear in the March issue of *The Welding Engineer.*

CHICAGO SECTION HOLDS MOCK TRIAL

The regular monthly meeting of the American Welding Society, Chicago Section, March 25, took the form of a mock trial. The case brought before the court was the supposed com-

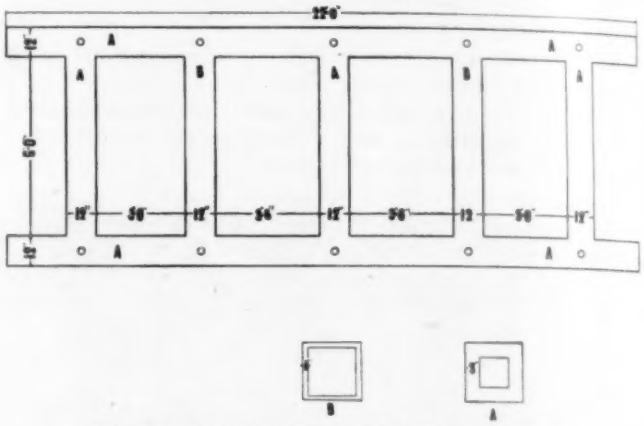
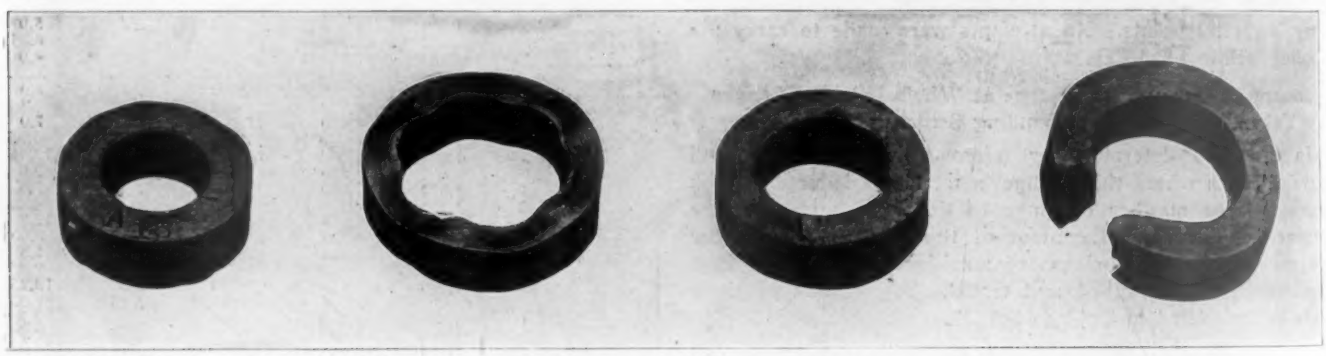


Diagram of Casting Discussed at Chicago Meeting.

plaint of a customer who had turned over to a job welder the casting, a Corliss engine base, illustrated in the accompanying diagram, to be welded. The customer refused payment on the job because he claimed that the casting cracked when it was put in service, while the welder claimed that it had been welded properly and cracked because it was not properly put in place after welding. The customer, Mr. Nack, a welder in the employ of The Able Welding Co., and the welder, Mr. Dean of the North End Welding Works were represented respectively by Mr. Senhert of Chicago Welded Products Co. and Mr. Maurer of Davis-Bournonville Co., acting as attorneys. Mr. L. B. Mackenzie, editor of *The Welding Engineer* acted as judge, and Mr. McCloud of the Gas Products Association as clerk. Evidence was presented by both sides and expert testimony was solicited from the welders present at the trial, before the case was turned over to the jury. The jury, Messrs. Kohlmo, Tollman, Smith, Ady, Van Dyke, and Bruszer, found that the work had been improperly done and the welder not entitled to his charge. Mr. Maurer then described in detail how the job had actually been handled in practice, as follows:

This casting is 22 ft. by 8 ft. over all. The two outer sections and the five cross members are all 12 inches square. The "A" members are 3 inches thick and the "B" members are 1 inch thick, as shown in the diagram. The crack occurred in the center cross member. Before welding the casting was lined up on fire brick on a dirt floor, and small charcoal fires built under each cross member. As the two end members began to



Left to Right, Figures 13 to 16.

13. Standard Specimen.—14 Base Metal (Ship Plate).—15. Deposited Metal (Bare Mild Steel Electrodes Used) Showing Fracture.—16. Same Expanded to Show Fracture.

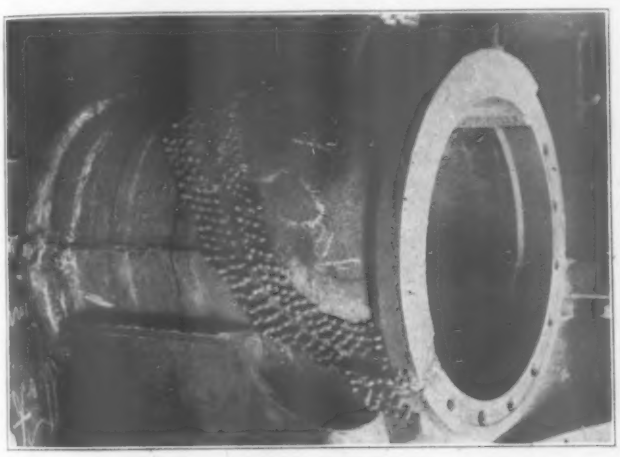
absorb heat the fracture opened. When the opening was about one-sixteenth inch wide the two sides were welded simultaneously, then the top was welded. After the three sides were welded the casting was turned completely over, the fires were rebuilt under each member and the casting preheated one hour before the final weld was made.

After welding, the fires under the A cross members were reduced and those under the B cross members were slightly enlarged. The A cross members were covered with one sheet of asbestos paper and the B cross members were covered with several sheets of asbestos paper. The reasons for taking these precautions were that the heavy sections would retain heat longer than the light sections, and it is necessary that all five sections cool at one and the same time, or as near to it as possible. The important part of this job is proper cooling. The only labor after welding might be to ream out some of the bolt holes.

PRACTICAL WELDERS DISCUSS THEIR WORK

Metropolitan Section Holds Live Meeting

On March 15, the Metropolitan section of the American Society held its regular monthly meeting at the Engineering Societies Building, in New York City. The program for the evening was something of a departure from the usual type, inasmuch as it did not consist of a single prepared paper by



Arc Welded Cylinder.

a single speaker, but was made up chiefly of brief talks by practical welders who explained in detail just how they accomplished the various results in their several shops.

The first speakers of the evening were two men employed by the Electric Arc Cutting & Welding Co., of Newark, N. J. They were Mr. G. Maubourene and Mr. H. Clark. These men described the method which they used in welding the spoke of a cast iron fly wheel which had broken in service. The fly wheel in question formed a part of the operating equipment of a plant which was run seven days a week and for this reason it was desired to expedite the repairs as rapidly as possible. These two men worked on opposite sides of the broken spoke using two arcs in series.

The second speaker was Paul Wittig, employed at the Kingsland shops of the Delaware, Lackawanna & Western. Mr. Wittig explained the manner in which a broken engine cylinder had been recently repaired. Lantern slides were shown to illustrate the various steps in the repair of this cylinder and a number of features developed which differed somewhat from the practices used on the other roads. The parts broken from the cylinder had been so completely destroyed that it was necessary to recast an entirely new portion and a wooden pattern was made which conformed exactly to the size of the broken off part. The new cast section made from this pattern was then studded with a large number of small steel studs as was also the unbroken portion of the cylinder. The question of placing studs in cast iron for the purpose of welding is not new, but the type of studs used in the Kingsland shops of the Lackawanna differs in some respects than those used on other roads. The stud itself is somewhat smaller and their practice is, at that point, to use a great many of these studs. A portion of the stud is threaded and screwed into the top hole in the cast iron in the usual manner. About a half inch above the end of the threads on the stud, a deep recess is cut so that the stud is materially weakened at this point. In applying the stud, a wrench is used on the end and as soon as the thread has been turned as far as possible into the tapped hole, further efforts applied to the wrench causes the stud to break off at this weakened point, which it is designed to do. This breaking off feature gives

Welding the Broken Engine Cylinder.

a very clean bright surface and one which may be readily welded to without the additional trouble of carefully cleaning.

John Marr, also at the Kingsland shops, gave a brief description of the method he used in welding fire boxes.

The subject of oxy-acetylene welding was taken up and discussed at considerable length by Fred E. Rogers, of the Davis-Bournonville Co., of Jersey City, N. J. Mr. Rogers described the application of gas welding to the construction of refrigerating apparatus and illustrated his talk with a large number of lantern slides.

Charles L. Messer, formerly employed at the West Albany shops of the New York Central, described briefly the method used by that company in welding broken cylinders and other standard cast iron parts. The stud method used by the New York Central varies somewhat from that used by the Lackawanna in that the studs used on the former road are considerably larger and fewer in number than those used on the latter. Moreover, instead of breaking off the studs in the manner used on the Lackawanna, they are thoroughly cleaned before welding.

The foregoing speakers gave extemporaneous talks, none of them having prepared any papers on particular subjects.

OXY-ACETYLENE WELDING ON REFRIGERATING APPARATUS*

By Fred E. Rogers†

PRIME requirements in refrigerating apparatus are pressure container strength and permanency of joints. Receivers, accumulators, coolers, pipes, coils and headers must be amply strong to resist the normal internal pressures applied, and all joints must remain tight under every condition of service.

Before the advent of oxy-acetylene welding in the United States about fifteen years ago, seams and joints were made up with forge welds, rivets, screw threads, flanges, gaskets, etc. Naturally, when oxy-acetylene welding was established as a commercial process it was taken up by some builders of refrigerating machinery and applied in the fabrication of their apparatus with the object of simplifying construction and making operation dependable. The industry is one of the pioneers in the use of the oxy-acetylene torch, and the developed general practice of welding pressure containers used in refrigeration satisfies all reasonable requirements for safety and reliability.

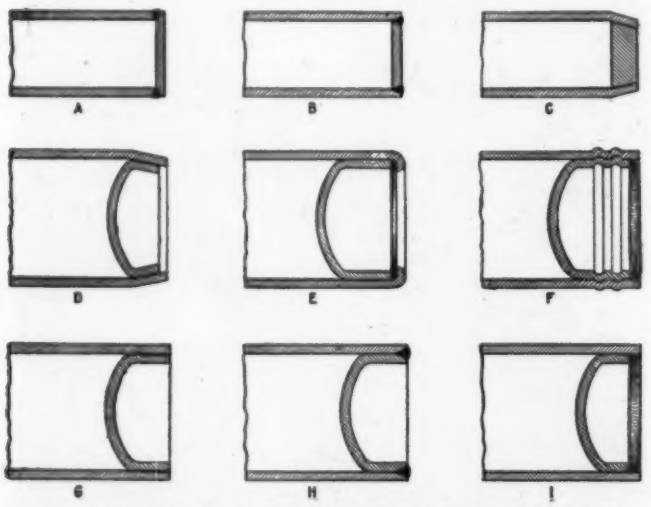


Fig. 1. Types of Heads Used on Small Diameter Pressure Containers.

Importance of True Forms

Pressure containers subjected to varying conditions of pressure change shape slightly unless the shells are made truly cylindrical. This weaving or breathing action if excessive may eventually cause cracks to develop, and it is of importance to minimize all movements of this sort, especially in or adjacent to welds. The shell should be rolled truly cylindrical and the edges bent to conform to the circle so that when joined and welded there is no appreciable flat section. If the ends of the sheet are not fully curved after rolling, the section will not be truly cylindrical and when the shell is subjected to internal pressure the flattened part changes shape, thereby setting up a bending stress in the weld and metal adjacent. When the pressure is relivered the parts tend to straighten again.

Too much stress can hardly be laid on the importance of sound mechanical practice on all work leading up to welding. True bevels, circular shapes, straight edges, convenient work supports and work-handling appliances contribute much to the success of welding.

Preparing for Welding

Several methods are employed for beveling the edges of points preparatory to welding, and while some are more efficient than others no absolute rule can be stated as the best to follow. Edges of flat plates may be beveled at low cost on a plate beveling planer before rolling them to cylindrical shape. Thus true beveled edges will be produced in the length and girth seams.

Lap welded pipe used for shells may be cut off and beveled in a cutting-off machine systematically and at low cost.

The flanged heads may also be beveled by chucking in a lathe, turning the edge to an angle while cutting the flange to length.

But in some cases owing to lack of equipment the ends of the shells are not beveled, and then the beveled flanges of the head is tacked to the end of the shell ⅛- to ⅛-inch apart at the bottom of the groove depending on the thickness. Again, neither the sheller nor the flange are beveled in which case more space between must be allowed when tacking. In other words, when preparation is incomplete it is provided for by allowing more space of filling material. The torch is used to break down the sharp corners immediately at the beginning of the welding, and the molten metal sloughs down and thus is created a groove for filling in.

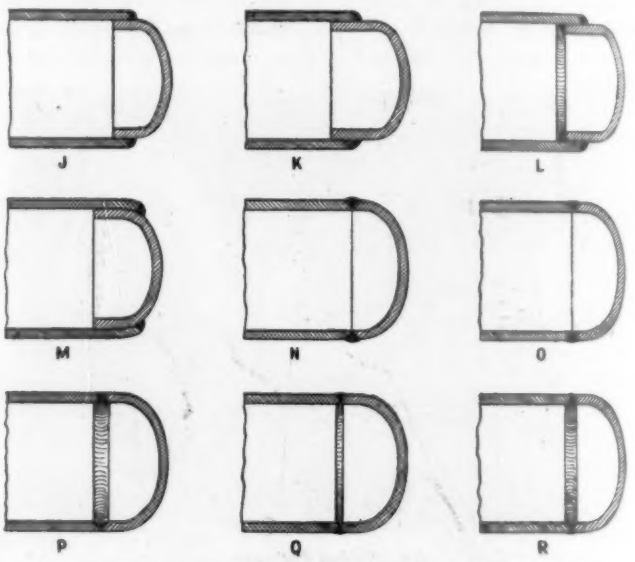


Fig. 2. Pressure Container Heads Used on Large Diameters.

Effect of Preparation on Joint

Recommended practice for work preparation is beveling the edges of the plate to an angle of 40 to 45 degrees which when two plates are butted together produces a groove of 80 to 90 degrees included angle.

In non-fired pressure containers practice varies in bevel preparation all the way from full preparation as shown at A through the stages B, C and D, Fig. 3.

When plates are fully prepared the lower edges are placed close together for tacking, but when the angle of groove is decreased as at B and C more space is allowed between for filling material. In short, the aim is to make the area of weld cross section approximately the same as in full beveling.

The point to be brought out is that there is a wide allowable difference in the method of work preparation provided the

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* *Paper read before the American Society of Refrigerating Engineers, December 7, 1920.*

† *Publicity Department, Davis-Bournonville Co., Jersey City,*

puddling practice is good. The cost of welding is greater when the bevels are incomplete as the corners must be broken down by the heat instead of a tool.

When the corners are broken down with the flame, there is danger of cold shuts forming on each side of the bottom between the molten and the parent metal. This potential defect can be avoided by skillful puddling with the welding rod which breaks the surafce tension and brings about cohesion at these points.

Attention may be called here to the fact that bevel preparation does not necessarily mean cutting to a sharp angle. It is

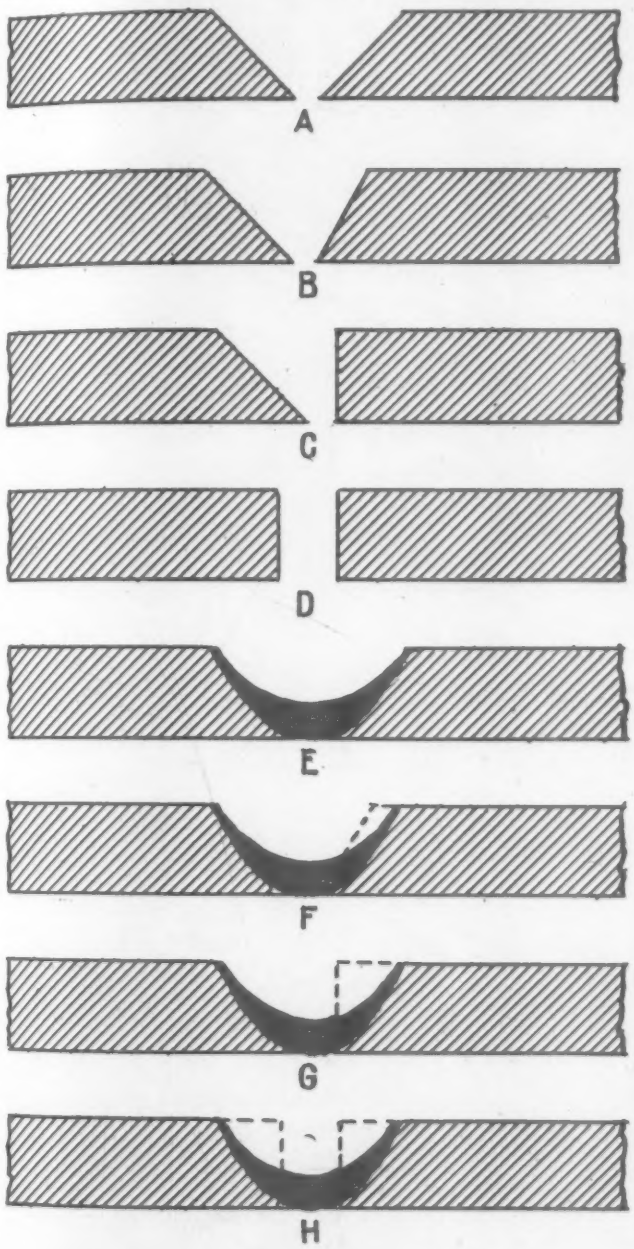


Fig. 3. Beveled and Non-beveled Joints, Showing that the Plates Should Be Tacked Further Apart with Square Edges than with Beveled Edges.

well known that steel plates ⅛-inch thick may be soundly welded without beveling if set apart 1/16- to ⅛-inch. By the same rule the bevel may be broken as shown in Fig. 4, leaving a step or square edge about ⅛-inch thick. The advantage is that less work is required for beveling and there is less likelihood of over-heating at the bottom of the vee.

Manipulation of Torch and Welding Rod

It is conceded that some torch manipulation and movement of the welding rod in certain relation are absolutely necessary to success in oxy-acetylene welding. There are, however, no absolutely fixed rules for securing sound work. The torch may be actively manipulated while the welding rod is moved but little, or the welding rod may be the more active factor while the torch is held comparatively still. The result is practically the same in either case and between the two extremes is a variety of practices, one merging into the other imperceptibly. The theory of torch and welding rod manipulation

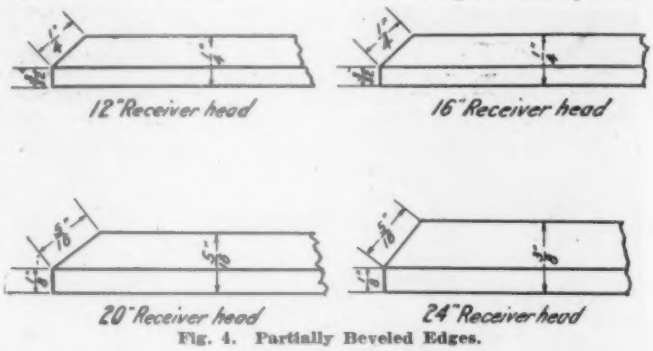


Fig. 4. Partially Beveled Edges.

is to distribute heat evenly on each side of the joint, to break down the walls and to secure thorough penetration and union of the adding material and parent metal. If the torch is active and welding rod passive the operator secures the de-

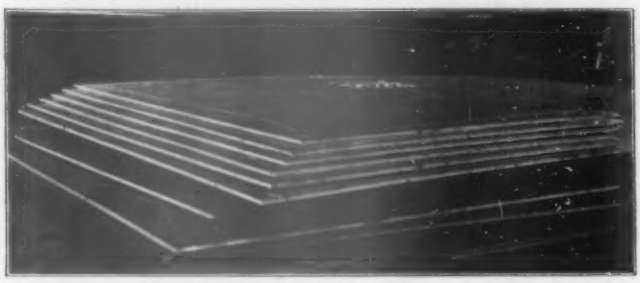


Fig. 5. Steel Plates with Length and Girth Seams Beveled on a Plate Beveling Planer.

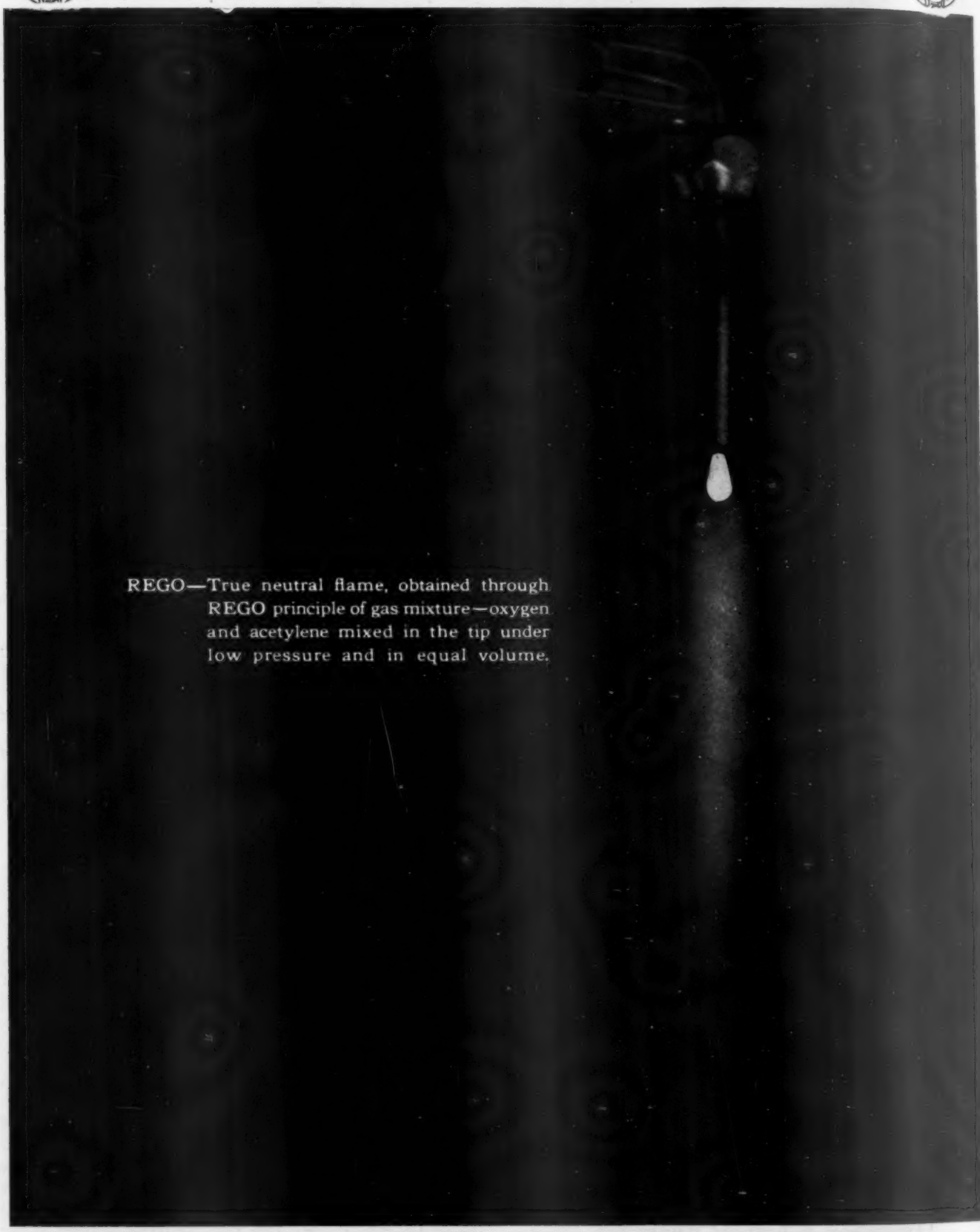
sired result by heat action and gas pressure rather than by rod manipulation. If, on the other hand, he works the torch comparatively little but actively operates the welding rod, penetration and elimination of oxide are accomplished mechanically as well as by heat.

One secret of success when welding steel plates having a

Fig. 6. Welding the Length Seam, with H-block and Wedge Ahead of the Weld to Hold the Edges Apart.

thickness up to ⅜-inch or more is to form a large puddle. The practice of one large refrigerating concern is to break down the side walls in advance of the puddle for a distance of 1¼-inch to 1½-inch, making sure that the metal is fused at the bottom of the vee. Then active puddling with the welding rod begins, the pool of molten metal being about ⅝-inch wide and ¾-inch long. The torch is whipped off the puddle from time to time. This causes the metal to "freeze" on the surface in semi-circular ridges.

WELDING AND CUTTING APPARATUS



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Penetration

As stated in the foregoing, the breaking down of the side walls is accomplished in such a manner as to insure perfect fusion of the metal at the bottom of the vee. It is against the practice of this concern to carry the penetration to such an extent that the metal drips through the joint and hangs in drops beneath, however. This condition is objected to, and the effort is to carry the weld through flush and no more.

On shells 44 inches diameter and larger another well-known concern welds the seams both inside and out thus insuring thorough penetration on the thicker metal as well as reinforcement sufficient to make the joint strength fully 100 per cent if required, which, of course, should not be.

Reinforcement of Welds

Obviously, it is possible to reinforce an oxy-acetylene weld to an extent that would absolutely prevent its ever breaking. The general practice is to reinforce the weld about 20 to 25 per cent, thereby making it somewhat stronger than the unwelded metal. The metal adjacent to the weld is coarsened in grain structure by the heat and somewhat weakened, however. The ideal condition then is realized when the reinforcement of the weld makes its strength equal to that of the metal adjacent to the weld. Any greater amount of reinforcement represents waste of adding material, gas and effort. In fact, it is positively detrimental because long-continued heating of the joint tends to decrease the strength of the unwelded metal subjected to the high temperature. The aim, therefore, should be to weld as rapidly as possible, to prevent the spread of heat to the degree consistent with thorough penetration and to add sufficient metal for reinforcement to insure strength of the metal in the weld equal to the strength of the metal adjacent to the weld, and no more.

Welders should be instructed to weld as they go and to avoid reheating a joint to produce a smooth effect. To one who knows good oxy-acetylene welding there is nothing more attractive than a regularly puddled weld. It has the marks of the master welder's hand and to the experienced is pretty fair evidence of the character of the weld.

Rigid and Non-Rigid Systems of Welding

When welding the longitudinal seam in a rolled steel cylinder single handed it is necessary to start welding at one end of the seam with the sides out of parallel a variable amount depending on the thickness of the metal, speed of welding and equipment provided for holding the parts in proper relation. A common rule for the thinner shell plates is to set the edges apart about ¼-inch per foot of length. The seam in a shell 8 feet long, for instance, would be tacked together at one end, while the gap at the other is held to about 2 inches. A somewhat greater allowance is desirable for plates ⅜-inch thick and more. Some concerns give considerable more allowance on even thinner sections running as high as six per cent.

This is an example of the non-rigid system of welding. The contraction of the cooling weld draws the edges of the plates together as the weld proceeds, and if the allowance has been correctly made and the welding has proceeded at a uniform

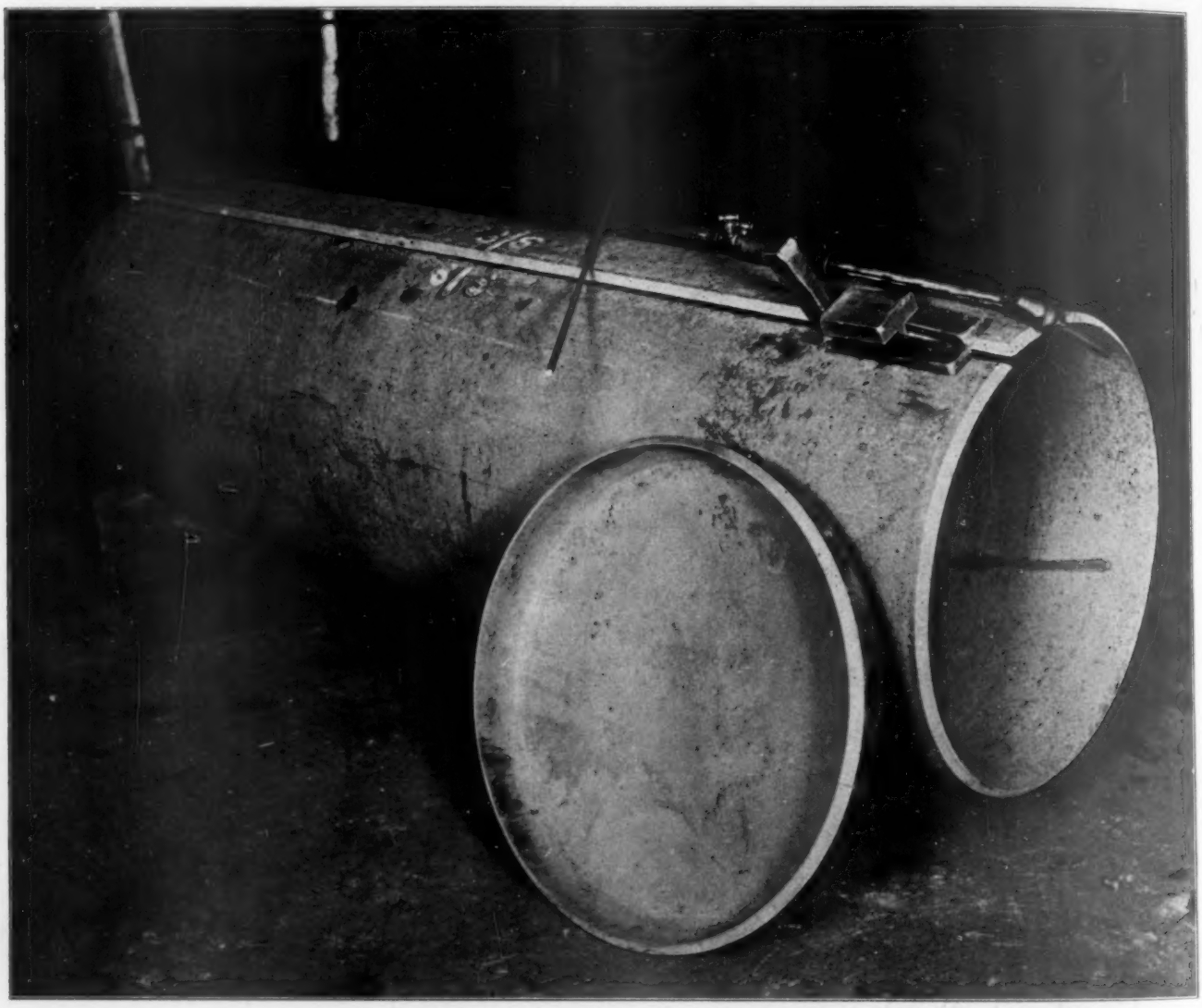
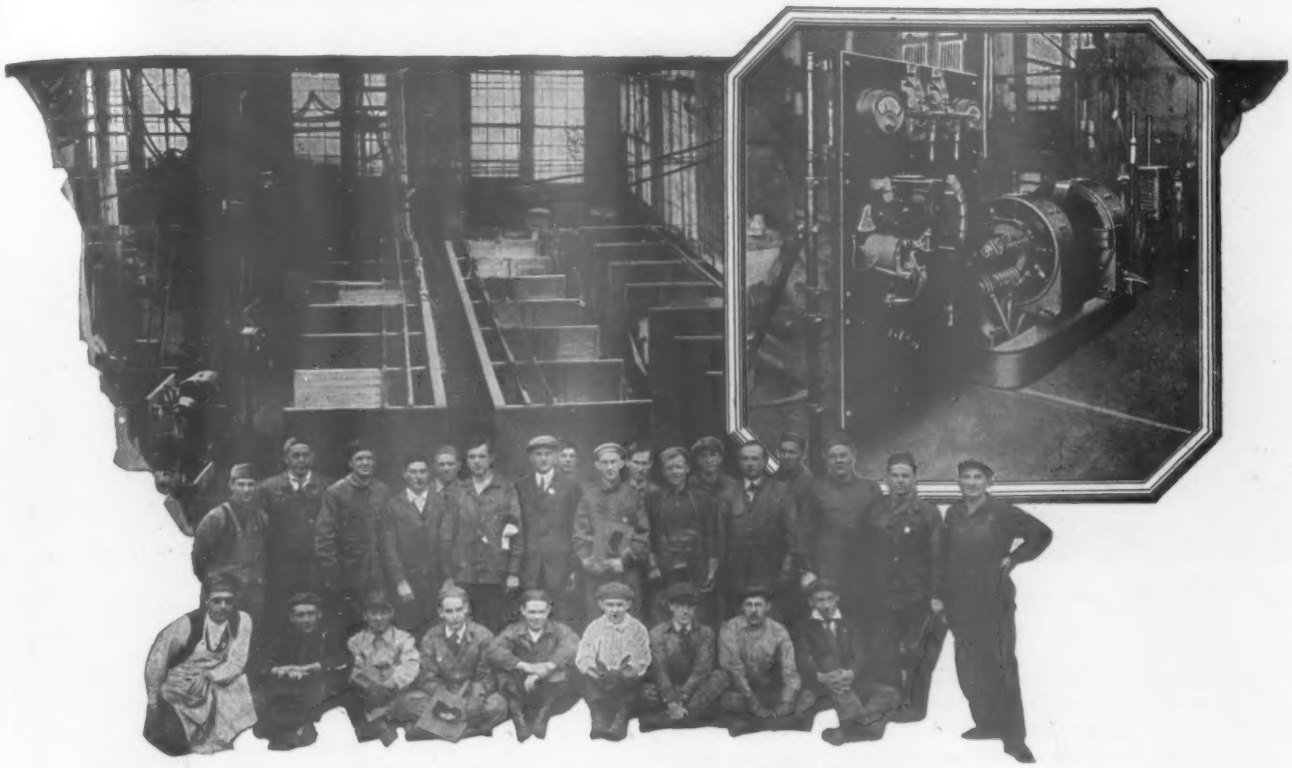


Fig. 7. Beveled Plate Rolled for Welding, with Wedge in Place.

Specialized industrial training eliminates mistakes that are costly in time and material



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rate the edges will be practically parallel when the end of the seam is reached.

If the attempt were made to tack the edges of a rolled sheet and to weld the seam with parallel edges, the result would be a peaked seam, the cross section looking more like a pear than a circle.

An example of the rigid system of welding is afforded when a flanged head is welded to the end of a pipe or cylinder. The practice is to tack the flange at four or more points and to

Fig. 8. Use of Screw Jack to Hold Edges Apart.

Fig. 9. Weld Half Completed Showing Joint Closed by Contraction.

start welding at one of the tacks, using a wedge ahead of the weld to prevent contraction of the cooling weld metal drawing the parts together faster than desired. When the welding has proceeded half way around or somewhat more the wedge is dispensed with and the weld finished without other support than the tacked and welded portions. In this case the strain set up by the contracting weld cannot seriously distort the joint and no allowance practically need be made for the con-

Fig. 10. Longitudinal Ripple Welded Seam.

traction of the cooling weld. What the strains are we can only guess. The fact that a circumferential weld is theoretically two times as strong as a longitudinal weld of the thickness and quality, however, makes the question of internal stress of little importance in girth seams.

Controlling Contraction

Blocks having a cross section like the letter H are used ahead of the weld to prevent the seam closing too rapidly. An H-block with broad lips permits the use of wedges between the lips and shell to keep the edges from getting "wapper-jawed," Alternative practice is to use a jack in the open end of the shell and to ease it off as the weld proceeds. Finally the edges close together at the termination of the weld.

More skill is required in welding longitudinal seams of pressure containers than on any other work done by the oxy-acetylene torch welder probably. The welder must secure thorough penetration and build up the weld to secure the maximum strength, while at the same time working the

Fig. 11. Flanged Head Tacked on Ready for Welding.

wedges to keep the edges true and the contraction proceeding evenly to the end so that when the weld is finished he shall have a straight seam and a truly cylindrical shell.

Welding should proceed from left to right, the torch flame being directed squarely against the declivity of the weld.

Size of Welding Rods and Tips

The size of welding rod used on steel shells $\frac{1}{16}$ to $\frac{1}{8}$-inch thick is from $\frac{3}{32}$- to $\frac{5}{32}$-inch, a common size being $\frac{1}{4}$-inch.

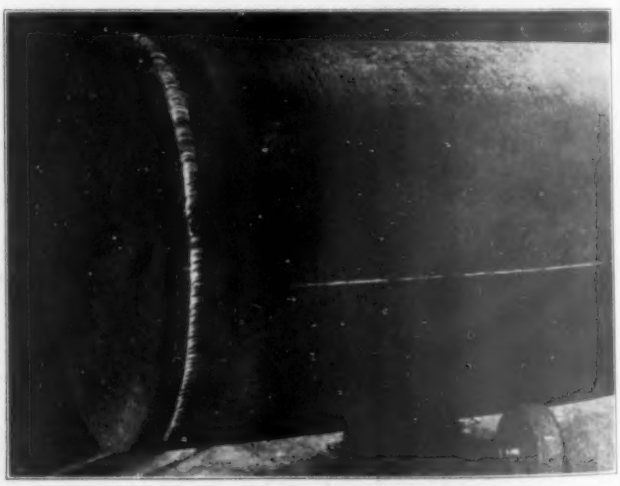


Fig. 12. Flanged Head Welded.

These sizes of rods favor working the metal and securing thorough penetration. They present less area to the flame in proportion to the contents than smaller rods, and tendency to opidation is lessened. Of course, a large flame must be used, the sizes of tips ranging up to No. 7 or No. 8 (Davis-Bournonville sizes, for this work in general.

Expansion and Contraction on Header Work

When a pipe nipple is set in the side of a header the job must be handled in such a manner as will insure being upright or square with the pipe when the work is cold. If only one nipple is set the job is comparatively simple as the operator need not take into consideration the accumulative contraction

PAGE-ARMCO WELDING RODS and ELECTRODES

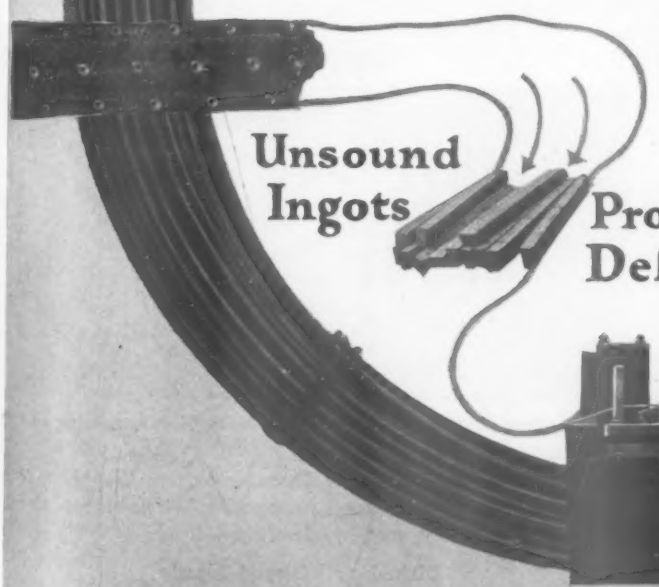
Consider the Ingot

One way to test the value of welding material is to actually try it out on the job. However, such tests are expensive, because if the welding material does not make good, time, money and material are wasted.

Consider **first** the ingot from which welding rods and electrodes emanate. Investigation should show the ingot free from impurities, blow holes, gas pockets and to be chemically uniform. The lack of uniformity throughout an ingot results in a "wild" assortment of wire. Actual tests made from borings prove this.

Examination of the Armco Ingot will give you positive assurance that every welding rod that is produced from it will be free from foreign matter and defects—that the proper fusion of welding material with parent metal **must** be perfect. It cannot be otherwise with iron uniformly 99.84 per cent pure.

Page-Armco Welding Rods flow freely and evenly under the oxy-acetylene flame and **Page-Armco Electrodes** maintain a dependable arc in the metallic arc welding process.



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effect of several welds. When a weld is made in the side of a pipe the tendency is to contract that side and bend the pipe. This is due to the expansion of the hot metal which causes upsetting as the cold metal surrounding it prevents full expansion. The subsequent contraction shortens the fibres on that side of the pipe and throws it out of straight line. However, the effect of the upsetting action is comparatively slight, and when only one nipple is set it will be imperceptible, especially if the pipe is of large diameter and comparatively short.

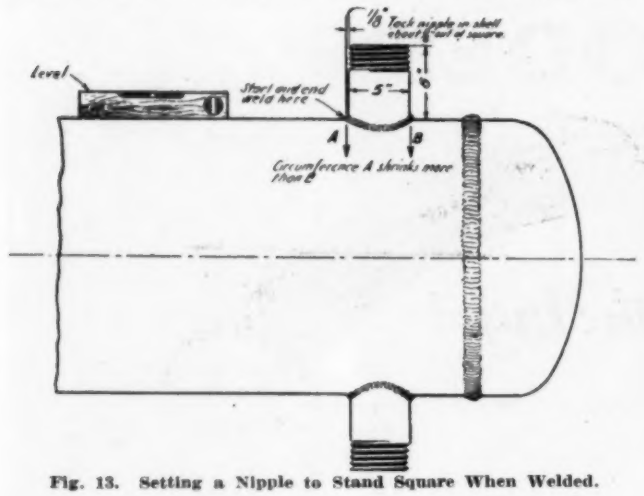


Fig. 13. Setting a Nipple to Stand Square When Welded.

When close to a head or flange the operator may then set the nipple out of plumb an amount depending on the length and diameter. A 5-inch nipple six or seven inches long projecting from the side of a pipe 16 inches diameter close to a head or flange should be thrown out of plumb about ⅛-inch, lengthwise of the pipe, and welding should start on the low side, or in the larger angle. It should continue around and finish at the same point. The effect of the expansion and contraction will be sufficient generally to square up the nipple. If the normal contraction effect is not sufficient it can be increased by again playing the torch flame around the base and cooling suddenly with wet waste.

The tendency to upright a nipple set and welded in the manner described may not be quite clear. It is attributed to the shortening of the circumferential fibers due to the repeated heating of the metal at the nipple base at the start and finish of welding. On the opposite side the metal is made hot but

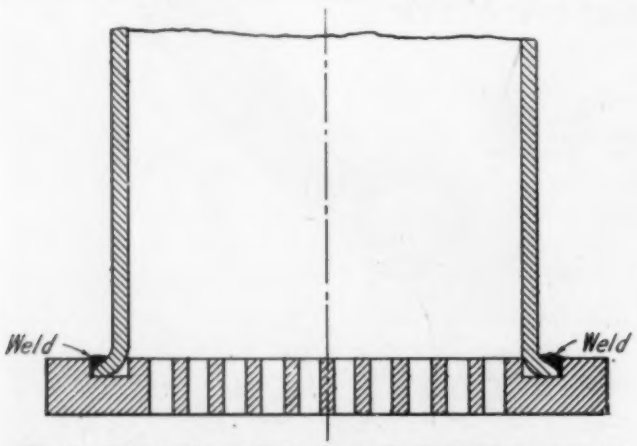


Fig. 14. Cross Section of Brine Cooler Head, Showing Groove for Flanged End of Shell, and the Weld.

once, and hence the shortening of the circumference is less than where the metal is made hot twice. Moreover, a flange or head resists contraction stress and tends to hold the metal at the base of a nipple close by rigidly in place. By reheating and sudden cooling the effect is accentuated. In fact, a welder experienced in the trick can actually produce a distinct wrinkle of depression in a shell.

Suppose that eight or ten 2-inch nipples are to be set in the side of an 8-inch pipe, ten feet long. Here is a condition in which the cumulative effect of contraction and bending is perceptible, and it has to be taken into account. The simplest plan is to use an 8-inch pipe bent so that a straight edge will show a drop of say ½-inch in the center. The nipples are welded in and the contraction produced by the upsetting action and subsequent cooling shortens the long side of the pipe, an amount that will depend on its length, diameter and number of welds on the nipples. The shortening effect should, of course, be just enough to make it straight. Small diameter headers of considerable length may be straightened after

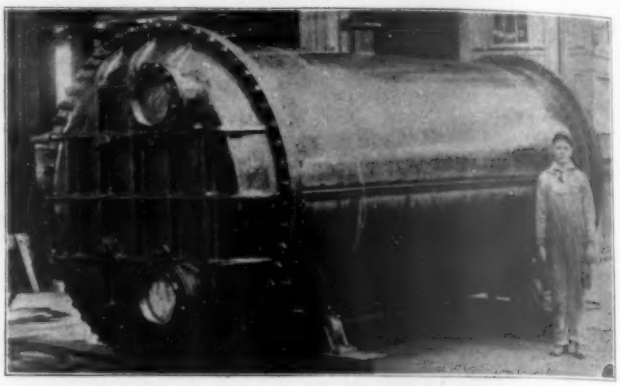


Fig. 15. Brine Cooler Assembled. Flanges and Longitudinal Seam Oxy-Acetylene Welded.

welding in the nipples by heating and bending the section between the nipples.

Flat Heads

Small diameter lap-welded pipe may be headed with flat discs set inside the pipe and welded at the edges, or the discs may be cut to the same size as external diameter of the pipe and welded to the end. Either form of head is objectionable from the standpoint of good design, but the welds can be made so much stronger than required to withstand the

Fig. 16. Four Welders Weld Flange to Brine Cooler Standing on End.

pressure in pipes of 8 inches diameter or less that there is no serious objection to such construction. The most elegant method, however, it to provide dished heads.

Dished or Flanged Heads

A cylinder with flat or dished heads subjected to internal pressure develops the severest bending stresses at the junction of the head and cylinder part. It is important, therefore, to locate the weld outside this zone. Forunately it can be easily accomplished by flanging the head and welding to the shell at a distance of two or three inches from the angle. The bending stress is thereby located in unwelded metal.

In some cases the flange is set inside the shell and welded in the outside corner. Large shells treated in this manner may be corner welded inside also. Another practice is setting the flanged head inside the shell, turning the end of the shell over the head and welding the edge. This makes a very strong job. In fact, it is much stronger than necessary, and is in

reality poor practice judged from the standpoint of engineering efficiency.

When dished heads are applied to receivers and welded with the oxy-acetylene torch the convex part of the heads is turned outward at both ends, of course, thereby giving the maximum capacity possible. If, however, the heads are welded in at the forge it is necessary to turn the convex sides of both heads in so that the ends may be welded on the anvil. With riveted construction the convex side of one head must be turned in to "hold on" and rivet the seam.

Welding Circulating Pipes

Small diameter pipes required for circulating coils in refrigerating apparatus may be butt-welded effectively with the oxy-acetylene flame, using a special torch designed to heat the joint throughout the circumference at once and means to apply endwise pressure when the welding temperature has been reached.

In general this welding is done with electric butt welding machines, however; clamps or tongs are used to smooth the butt weld while the metal is hot and to compress the pipe to the original diameter. Care should be taken to joint the ends squarely in order to get even heating and to avoid flashing, which would throw projecting fins into the pipe and cause interference with the flow of liquid.

Testing Welded Apparatus

Ammonia receivers and accumulators with auxiliary apparatus are tested with water pressure using a hydraulic pump and accumulator to develop pressures several times higher than the working pressure. To make the test more severe the shell is sometimes hammered adjacent to the welds. If no leaks develop under the hydraulic test the apparatus is then subjected to air pressure of about three-fifths the hydraulic pressure, the object then being to find minute leaks which may have escaped notice under the hydraulic test. When conducting the air pressure test the apparatus is placed in a large shallow metal tank party filled with water. Any leaks are betrayed by air bubbles. In this manner it is possible to locate minute leaks which would not be found by hydraulic test.

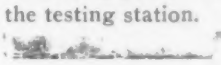
Training Welders

Naturally, a trade like oxy-acetylene welding in which so much depends on the personal equation has drawn attention to the need of training men to produce sound work. There are several methods of training raw labor to manipulate the welding torch. No doubt the best method is that which expounds principles and enforces practice in approved torch manipulation. Testing the welds is also a prime requisite in a training course. If a learner sees the inside of a defective weld made by himself, which looks fair on the outside, his conceit is taken down a bit. He learns rather painfully what to avoid. Manufacturing concerns must follow methods depending on the size of shop and class of work, however.

One concern starts off a learner with a cutting torch. The man is carefully instructed in its construction and manipulation—how to turn on the gases, light and adjust for the preheating flame and to turn on the cutting oxygen when the igniting temperature has been reached. After that he is allowed to play with the apparatus for a day or two when he is given some simple designs to cut out of sheet metal, When these have been successfully mastered he is given simple blueprints and told to cut out the designs, making his own measurements. This means training in other matters than cutting, and the new men soon acquire facility in the use of tools and acquaintance with shop practice, all of which has bearing on their success as welders.

After using the cutting torch for two or three weeks the men who have demonstrated that they have the qualities necessary for good welders are given welding torches and started at work on non-pressure apparatus, water tanks, and on water headers subjected to little pressure. From this work they graduate to ammonia apparatus. It is truly surprising how quickly some men master the principles of sound welding and become competent to do the most exacting work on high pressure ammonia parts. It is needless to say that anyone acquainted with oxyacetylene welding will readily see that in such apparatus we have the highest and most exacting requirements. An advantage of this method of training welders is that each welder becomes familiar with the use of the cutting torch and uses it as an auxiliary tool to facilitate his work.

For instance, when making receivers or accumulators from standard lengths of lap-welded pipes, it may be necessary to cut a length of pipe into three or four pieces. This can be done in a well-equipped shop to advantage on a pipe machine, the bevelling being done at the same time. But in a smaller shop not so well equipped the cutting torch is used for cutting the pipe into lengths, having first marked the cut layout with chalk. The pipe resting on vee roller rests is slowly turned while the cut proceeds. When the welder has cut his pipe into sections he is ready then to weld on the heads and to cut the openings for nozzles, nipples and other connections. This work is done in proper sequence, the result being that the welder practically handles the entire proposition from the time the pipe comes into the shop until it leaves him to go to the testing station.



Morale of Welders

An illustration of painstaking care to preserve a high standard of excellence is shown, this being the end of an ammonia receiver having three sockets welded on for the pipe support on which it stands. Tack welding would be quite sufficient to hold the sockets in place. The stress tending to displace them is comparatively slight, most of the load being compressive. But the welders are required to weld these sockets to the heads with all the care bestowed on the nipple shown in the center. The reason is to prevent any lowering of the standard of performance. The slight increase of cost is cheerfully borne as the need for searching inspection on other work as it progresses is thereby reduced. Moreover, the welders work with greater satisfaction and take more pride in their production when they are held rigidly to the highest attainable standard at all times.

NEW OFFICE OF AIR REDUCTION CO.

The Air Reduction Sales Company will move its executive offices on May 1st from 120 Broadway and 160 Fifth Avenue to 342 Madison Avenue, New York City.

This move to Uptown New York on the part of one of the country's largest producers of oxyacetylene welding products comes as a result of the company outgrowing both its 120 Broadway and 160 Fifth Avenue accommodations. The concentration of all its general office departments in one building, it is thought, will make for more convenience and efficiency in their dealings with the Airco District Offices and distributing stations located in practically every large city of the country.

Coincident with the announcement of the general office change is another to the effect that the New York district office of Airco after May 1st will be located at the Airco factory, 191 Pacific Avenue, Jersey City, N. J. All correspondence and other communications heretofore directed to the Airco district office at 160 Fifth Avenue, New York, should in the future be sent to 191 Pacific Avenue, Jersey City, N. J.

VAN SCHAICK MADE SALES MANAGER

The Page Steel and Wire Co. announce that Mr. A. P. Van Schaick is appointed General Manager of Sales, succeeding Mr. E. C. Sattley, resigned. Mr. W. T. Kyle is appointed Assistant General Manager of Sales. Mr. Van Schaick and Mr. Kyle will both have headquarters at 1054 Grand Central Terminal, New York City.

The Welding Engineer

Reg. U. S. Pat. Office.

Published on the 17th of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,

608 S. Dearborn St., Chicago, Ill.

Telephone Wabash 7134.

L. B. Mackenzie.....President and Editor
H. S. Card.....Associate Editor

Subscription payable in advance and postage free.
United States and possessions and Canada.....$3 a year
Foreign Countries ..... 4.00 a year
Single copy, domestic .....25 cents
Single copy, foreign .....30 cents

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

The Welding Engineer is a member of the Audit Bureau of Circulations and of the Associated Business Papers, Inc.

Last Advertising forms close at 8:00 a. m. on the 15th. To show proof for correction copy must be received at an earlier date and allowances should be made for delay to mails.

The Welding Engineer is the official organ of the American Welding Society.

Eastern Office:
171 Madison Ave., New York. Telephone, Murray Hill 4394.
Max I. Barth, Eastern Representative.

The Welding Engineer in Australia and New Zealand.
Mr. R. Hill, Matlock House, Devonport, Auckland, New Zealand, is our accredited representative in Australia and New Zealand for obtaining new subscriptions.

VOLUME 6 APRIL, 1921 NUMBER 4

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The Reporter and Acetylene

THE following notice was printed in the Cleveland News on March 23, 1921:

Dying From Burns

Richard Connors, 15911 *Olive Court, is reported dying in Lakeside Hospital from burns received at noon Wednesday when an acetylene torch with which he was working at* 3609 *Lakeside Avenue, exploded.*

After having made a preliminary investigation at the Central Police Station of the above related accident, one of our readers went to 3609 Lakeside Avenue to get further information. The place is a scrap yard conducted by Rosenblatt & Sons' Co.

Several asphalt drums approximately 30 inches in diameter and 45 inches high were on the ground, one of them badly scorched. One end of this drum was brown clear out by the force of the explosion and was found about 400 feet away from the yard. The other end was cracked and bulged. A small hole near the edge of the loose head showed that the cut had just been started when the drum exploded and covered Connors with burning asphalt or possibly oil.

The cutting equipment was not at fault and as far as our informant could determine acetylene was not even used on the premises.

Possibilities for Extending the Oxy-Acetylene Process.

THE superintendent of a large chemical and fertilizer plant in New Jersey has saved his company $50,000 in the past three years largely because of his ingenuity in applying the oxy-acetylene welding and cutting process. Much of this saving resulted from utilizing materials salvaged out of the scrap pile for the fabrication of equipment that would otherwise have been purchased new.

From the foregoing it would appear that the oxy-acetylene process as commonly practiced in production and repair may be profitably extended to embrace a variety of economic operations that in many plants are entirely overlooked.

As in a general way the same class of opportunities may apply to manufacturing plants of other kinds, references to the typical fabrications at the plant noted ought to be of suggestive value. The principal ones are briefly outlined as follows:

(a) In one instance a 4-inch steam pipeline, 300 feet long and carrying 150 pounds pressure, was constructed of second-hand pipe sections joined by butt welding. This line was put in service three years ago, and has not shown the slightest trace of a leak at any point.

(b) Another instance of the use of scrap material was the fabrication of two oil and water separators from old pipe. These separators were more compact and workmanlike than the manufactured article.

(c) Yet another instance of the use of scrap pipe was the building of a degreasing condenser from this material. The original condenser was built of screwed pipe and fittings and the loss through leakage of gasoline amounted to 18 gallons for every ton of fertilizer degreased. In the improvised welded condenser the loss was reduced to 3½ gallons per ton.

(d) In the conversion of a coal-burning power plant to burn oil, $2,160 worth of assorted pipe fittings were saved by welding in small nipples instead of cutting the main line and inserting "tees."

(e) On another job thousands of pipe clamps and bolts were eliminated by welding electric conduit tubing to the web of "I" beams.

(f) In other case 5-foot "U" bends were made from scrap pipe. These bends, in which the oxy-acetylene flame was used, were not so symmetrical and uniform as the manu-

The ambulance of Industry

THE oxy-acetylene welder's hand-truck is the ambulance of the modern machine shop. Instantly accessible, quickly and easily wheeled to any part of the shop, wherever the job may be—the oxy-acetylene outfit saves thousands of dollars by eliminating delay and reclaiming broken parts.

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has made possible the use of a highly pure gas in an easily portable and economical form.

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PW-505-21

factured article, but were much cheaper and proved highly efficient in service.

(g) The oxy-acetylene torch was used also in making stairways and handrails. For treads 6 by ⅛-inch steel channels were welded, hollow side up, to steel channel stringers. The treads were filled in with steel borings and cement to make a non-skid surface. The verticals were welded to the sides of the stringer channels, the handrail being laid in a round groove at the top of the verticals, thus completing, after being welded, a staircase that was rigid and permanent. This application eliminated numerous railing fittings and adjustments at various angles of the stairways.

These instances, strikingly illustrate some of the possibilities of the oxy-acetylene process for producing saving other than those commonly effected in the factory and repair shop.

Jerry and Jim

JERRY and Jim, who are introduced to the trade in this issue of *The Welding Engineer,* are a couple of welders who can be found in almost any welding shop which employs more than one welder. Jerry accomplished this biggest welding job that was ever pulled off in this country or any other country. It was so big that none of the standard torches would do the work, so he had to make a special torch for it before he could begin. The finished job was so good that they took a picture of it! All this can be gathered from Jerry's conversation. In fact, Jerry has so much conversation that Jim doesn't get time to say much—but from the few words he does manage to put in we judge that Jim is a doggone good welder.

PHILADELPHIA SECTION HOLDS ANNUAL MEETING.

The annual meeting of the American Welding Society, Philadelphia Section, is scheduled for Monday evening, April 18, in the Philadelphia Engineers' Club Auditorium. The program includes reports from committees, the announcements of the newly elected officers, as follows:

Past Chairman—Joah Brogder, David Lupton's Sons Co.
Chairman—Wm. T. Bonner, N. Y. Shipbuilding Corp'n.
1st Vice-Chairman—Victor Mauck, Jno. Wood Manfg. Co.
2nd Vice-Chairman—Dr. H. S. Lukens, Univ. of Penna.
Secretary—H. J. Grow, Philadelphia Navy Yard.
Treasurer—C. W. Bates, Philadelphia Electric Co.

Executive Committee Members—Three years, C. J. Mooney, Linde Air Prod. Co.; G. W. Scott, Wm. Cramp & Sons Co.; F. W. Anderson, Atlantic Refining; L. H. Swind, Swind Machy. Co. Two years, C. K. West, Gen'l Elec. Co.; Jesse Gilbert, Link Belt Co.; Lt. Com. E. F. Enright, Philadelphia Navy Yard. One year, I. D. Shipper, J. G. Brill Co.; S. G. Child, Baldwin Locomotive Co.

Addresses by J. H. Deppeler and W. T. Bonner, and motion pictures showing the production of welding rods from ore to electrodes, showing mining operations, transportation, blast furnaces, rolling mills, wire straightening and cutting, etc., with explanatory lectures by Engineers of the American Rolling Mill Co., and the Page Steel & Wire Co.

OXY-ACETYLENE USED IN BREAKING UP CONCRETE

In a building under construction in Cleveland, Ohio, considerable concrete work was put in through an architect's error. It was found necessary to remove the misplaced structure, and a crew of laborers assigned to the task attacked the concrete with sledges and drills. At the end of three days the progress made was so small that other and more rapid means of removal became imperative.

In the emergency a practical gas welder was called in to determine what could be done with the oxy-acetylene torch. A demonstration proved the feasibility of speeding up the work with the torch and the job was thereafter turned over to a local welding firm.

The method employed consisted of heating along the line of the desired fracture with an ordinary welding torch, using a long bushy flame. The concrete was not raised to a great heat, as measured in terms of oxy-acetylene, but the heat was confined as much as possible along the proposed line of fracture. When so heated the concrete yielded to a heavy blow of the sledge, breaking off in the predetermined form and bulk.

PORTABLE GRINDER SAVES A MAN A DAY

Slow methods of working often look like economy because their wastefulness is not apparent. The welder who shakes his head at the proposition of installing good machinery may be overlooking a good bet. A recent case illustrative of this is that of a welder who purchased a portable electric grinder from the Wodack Electric Tool Corporation. After using it a while he wrote to Mr. Wodack, "It has enabled me to do the work that I formerly had two men on with one man, or a saving of $4.25 per day. Besides it will file off the hard spots and get in close corners where a file will not."

AIR REDUCTION HAS NEW PLANT

The Air Reduction Sales Company has secured control of the National Carbide Corporation of Virginia, with a new planit at Ivanhoe, Va., and beginning May 1st, 1921, will direct the policy and control the operation and sales of the Carbide Corporation.

With the acquisition of this carbide plant the Airco organization (Air Reduction Sales Company) places itself in the unique position in the oxyacetylene welding and cutting industry of manufacturing and selling within its own orgaization everything necessary in the use of the oxyacetylene flame. Airco products now include oxygen, acetylene, welding and cutting apparatus and supplies, acetylene generators, carbide, nitrogen and argon.

The carbide produced at the new plant will be marketed in the future as Airco Carbide through the chain of Airco distributing stations stretching over the country.

NOXON MADE SALES MANAGER

"W. R. Noxon has been appointed sales manager for the Alexander Milburn Company, Baltimore, Md. His experience in the oxy-acetylene line is very extended. It began in 1908 as sales manager for the Davis-Bournonville Company, New York. After an interim in 1914-1915 he was reengaged as district manager at Chicago, Ill., continuing in that position until recently."

RIVET CUTTING RECORD

What is believed to be the record to date for cutting rivets in the dismembering of steel freight cars was recently established by an operator who cut out 1,038 rivets in 2 hours and 46 minutes. Of this number 683 were ⅝-inch rivets, 228 were ¾-inch rivets and 127 were ⅞-inch rivets.

The cutting was done on a standard Erie car under general yard conditions, the operator taking the rivets as they came, working inside, outside and under the car. The car was one that had been retired from active service and that was in the car shop for repair, the rivets and plates being covered with heavy scale and rust, thereby rendering the cutting extremely difficult.

It is said that the record applies not only to the number of rivets cut in the time required, but also to the low consumption of gases used, the job taking only 384 cubic feet of oxygen and 83 cubic feet of acetylene.

NEW BUTT WELDER

The Winfield Electric Welding Machine Co., Warren, Ohio, recently announced a new type of butt welding machine, especially designed for work on high speed drills. It is said that the construction prevents the flash from the weld from getting into the movable parts or bearings.

"U. S." Acetylene Generators

Simple—Efficient—Automatic

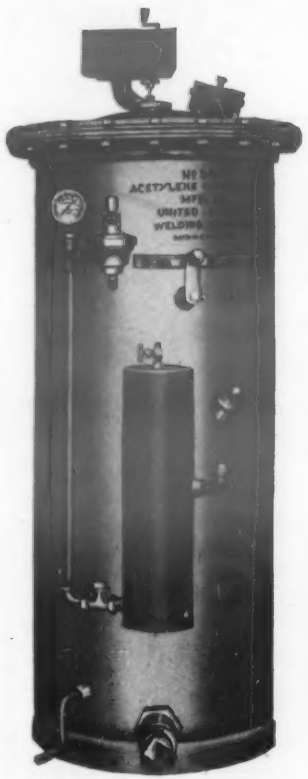
LOW-PRICED

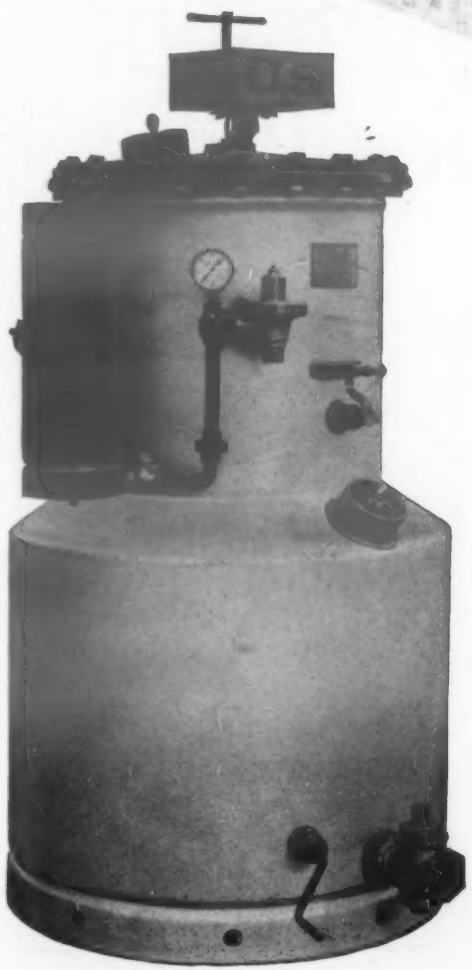
Makers of famous "U. S." Welding and Cutting Apparatus

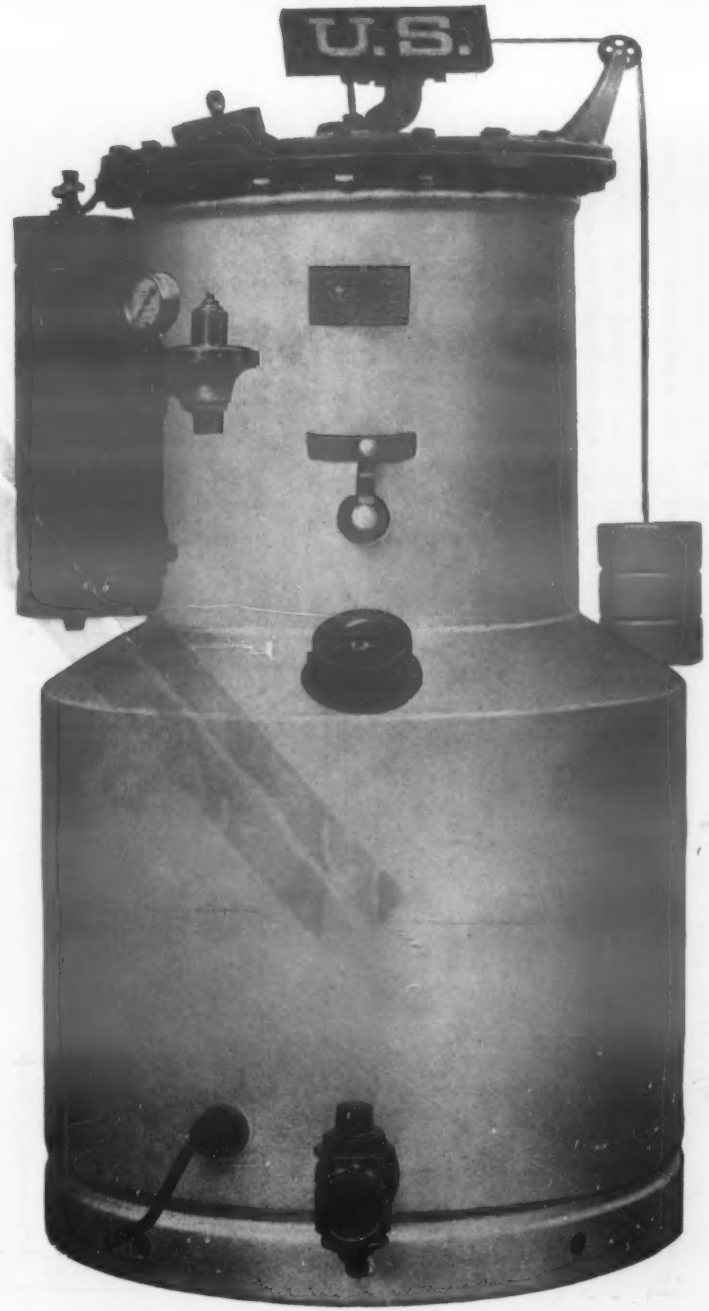
UNITED STATES WELDING CO., Inc.

Minneapolis, Minnesota

Distributors Wanted—Write for Particulars

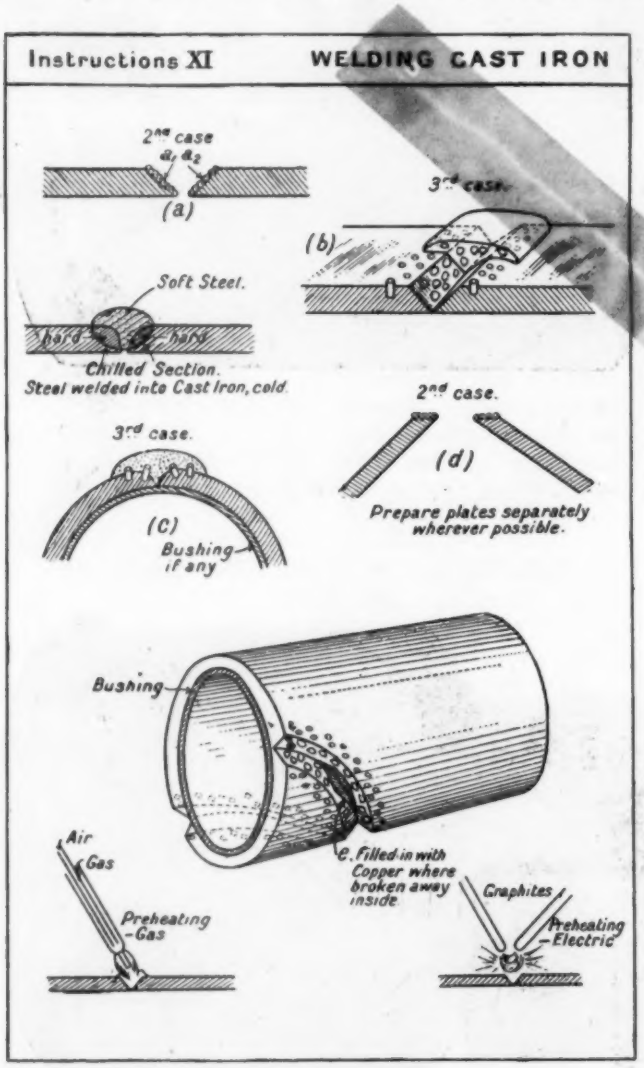






WELDING CAST IRON

FIRST CASE. Simply as a means of filling in, or building out, where grinding is the only machining necessary. Clean out the spot to be welded by chipping or grinding so that all dirty, oily, sandy, or porous metal is cleaned away and a reasonably bright metal foundation is provided for the weld. Weld with either steel or cast-iron electrode, according as to whether a reasonably hard or a very hard surface is wanted after grinding. The steel gives a hard surface and the cast iron a very hard surface. Care must be taken in using the cast-iron electrode that the quick cooling does not catch gas bubbles in the



weld, leaving holes after finishing. The steel causes no such trouble, but if one or two imperfections show, a peening hammer will close them up.

SECOND CASE. Welding cast iron, where tensile strength is required, but no resistance to bursting pressure will be experienced, *i. e.*, welding broken machine-parts, bed-plates, etc. In general, where no undue strain results, and the part was originally broken by some accident which will hardly happen again in the same place, *i. e.*, "V" out wide enough so that the electrode can be held at approximately right angles to either face of the "V." Weld the two faces of the "V" separately with steel, using great care to have the steel united to the face as the arc progresses, and not let any of it run down ahead of the puddle; weld from the bottom up, and, if any of the deposited metal does get away, stop and chip it off. After the two faces are successfully covered, it is extremely easy to make a good weld from the steel faces, using steel or cast iron in the "V."

THIRD CASE. Welding cast iron where heavy bursting pressure is to be met or great tensile strength is required. Use steel studs in single or double row either side of the "V," *i. e.*, from 1 in. deep on the upper half of the "V." The studs to be ⅜ in. to ¾ in. diameter, depending on the size of the work, to be screwed into a tapped hole from ½ in. to 1 in. deep, according to the thickness of the work. Saw off ⅛ in. to 3/16 in. above the surface of the work. First: Carefully weld round the studs so that the studs are part of the cast iron, then weld diagonally as in lacing a shoe across the weld from stud to stud, and finally finish as with a pad over all completely covering the studs. In general studs of steel are needed in a number so that their cross section by 60,000 lbs., their strength, equals the cast-iron section by 18,000 lbs. its strength, *i. e.*, about one-fifth the area of steel studs to the C. I. for a 100 per cent job.

The first welding from stud to stud draws the casting together into original contact, especially if a small amount of the original break is left intact at the bottom of the "V." This can be done except in the instance where the piece breaks out and is lost, as in engine cylinder wrecks. A bottom of copper forced in with an air hammer should be used so that for subsequent machining the chilled cast iron surface under the weld will not be met. In general, much more satisfaction can be had by introducing a bushing, especially in large cylinders, which bushing makes the piston fit, the weld simply taking the bursting strains. Many cylinders are supplied with the bushing originally, and in welding the bushing should be removed and replaced after the welding job is finished, machining slightly to size if necessary.

FOURTH CASE. Welding cast iron for subsequent machining through the weld. In all of the foregoing cases the weld may or may not be machinable, but the chilled layer of cast iron directly under the weld will seldom be machinable except for very thin pieces, due to the cast iron having been heated and chilled quickly and uncombined carbon left in its graphitic state.

To remove this hardened layer when welding with steel, and to remove the entire hardness of the entire section when welding with cast iron, the following procedure must be gone through. Where the piece is of such shape that it can be welded cold, reheating and annealing will make it machinable, *i. e.*, any time after welding bring the weld and adjacent cast iron up to a little better than red heat and allow it to remain there from two to ten minutes depending on the size of the piece, then cool slowly by burying in warm sand, fire-clay or limestone. Where piece is of such shape that the cooling strains when welding quickly, as in electric welding, would warp or break the piece, preheating is necessary, but only to a small degree *i. e.*, less than red heat, in order to save the piece from breaking while welding. Directly after welding, bring the weld and adjacent cast iron up to better than red heat and anneal as before. This method results in either steel or cast-iron electrode applied to cast iron being entirely machinable, and in the case of cast-iron electrode results in a weld which is not discernible from the original cast iron by either physical or chemical analysis.

In general, cast iron containing small amounts of steel, *i. e.*, so-called semi-cast iron, is much easier to weld than pure cast iron. Generally, the only welding done on cast iron, except in the cast of accidents, is where the original cast iron is defective because of sand holes, porous spots or other trouble in casting: this slag must be entirely removed before satisfacory welding can be expected.

Usually the cast-iron electrode, while it becomes more fluid than steel under the arc, cools quicker than steel and from the outside inwards, because steel cools by the conduction of the heat in weld into the adjacent metal from the inside outwards, and hence with cast iron there is more chance of voids and gas bubbles being left in the weld and some sort of flux to prevent this is necessary in depositing cast iron. Desirable ingredients in such flux being:

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* *Instruction No. 11 from the handbook of the Electric Arc Cutting & Welding Co., 152 Jelliff Ave., Newark, N. J. Copies of the complete instruction book may be had from this company at $1.25 each.*

1. Quieting reagent.
2. Quick floater of dross to the surface.
3. Oxygen and nitrogen protector, so that bubbles, films or needles of oxide and nitride are not left in the weld.
4. Protection against rapid cooling of surface.

Such a flux is furnished with electrodes, besides especial care being taken that the C. I. welding rod is homogeneous and flows evenly through the arc.

Generally, careful spreading is the successful method to apply cast-iron electrode to cast iron; with steel electrode on cast iron, careful beading at the start and careful spreading as a finish.

NOTE.—The method of studding cast iron to give increased reliability and strength was developed by Mr. Joseph McAllister, of the New York Central Railway, U. S. A., and under his direction was successfully applied to the maliciously broken cast-iron cylinders and other parts of the interned German ships in New York harbor, using the plant and resources of both the Erie and New York Central Railways.

Cast iron differs from steel in containing around 3½ per cent carbon whereas steel, even the hardest, contains less than 2 per cent carbon, and 98 per cent of all steel in the world has less than $\frac{1}{10}$ of 1 per cent carbon. The cast iron with the same amount of carbon in it may have the carbon in two forms, that is, combined and uncombined. In the combined form the cast iron is very hard. In the uncombined form it is comparatively soft, easily machineable, and can be caulked. Various degrees of hardness range between these two limits according as to whether all of the carbon has flaked out of the combination into graphite, or whether some remains. The conditions as to whether the graphite will be separated, or in combination, depend on the rapidity of the cooling from a temperature just above the red heat. If it is cooled rapidly there will be no time for the graphite to come out of combination. If it is cooled very slowly, the graphite will all come out of the combination and various degrees of hardness are obtained by the differences in the time of cooling. A form of cast iron called malleable cast iron is rapidly becoming extinct, and which after weeks of slow cooling, the graphite settles to the outside and is taken off the cast iron, it begins to take on the properties of wrought iron. As aforesaid, this is drawn off, and real malleable iron is rapidly going out of use due to the time taken to make it. So-called malleable iron is generally cast iron with very little of the graphite removed. In making a weld on cast iron cold, naturally the cast iron is cooled very quickly, or chilled just below the joint of the weld and sometimes the weld itself will be very hard because of the very quick cooling. This occurs whether welding with a steel, electrode or with a cast iron electrode. This chilling, hardening effect can be removed by reheating and annealing in lime or warm sand, or any way to allow it to cool slowly from above a red heat.

Cast iron will not suffer any permanent deformations; in other words, it cannot be bent, stretched or put out of its original alignment in any manner without breaking or cracking. To relieve the stresses, set up in welding cast iron cold, the weld must contract and if the shape of the cast iron pieces is such that one or both ends cannot move in with the weld, something must give. If the weld is one-quarter or less of the section of the cast iron and a good joint is made to the cast iron, the weld will stretch, because, although the weld even if of steel, being four times as strong as the cast iron section will, if it is one-quarter or less in area, stretch and it does not hurt the weld to stretch. It is similar to working steel after casting into forgings and rolled shapes. If the weld can be put on a little at a time, so that its cross section is also less than one-quarter of the cast iron which it is welded to, results can be obtained which will not bend out of the original position, even on a section that is ultimately the same size.

The foregoing applies to welding with the steel electrode. In welding with cast iron electrode, the relative strengths would be the same, but due to the cast iron weld not being able to stand any deformation, it would crack through the weld. The remedy for this is to preheat the parts to be welded so that they will all contract at the same rate. In this manner welding with a cast iron electrode is much more rapid and more satisfactory than any other process. The arc has a tendency to burn out the carbon in any welding and there is an especially fertile field where the carbon is 3½ per cent. We have developed a coating for the electrodes which resupplies this carbon by adding an excess so that true cast iron of the same nature as the original is deposited in the weld.

Another method of welding cast iron is to anchor the steel weld to the cast iron by means of studding as shown in this chapter of the instruction book, so that the weld in contracting cannot pull out of the cast iron no matter what the relative sections. In this manner the weld to the cast iron is made as well as to the steel studs, and the weld is by far the strongest part of the job. This is the method that was used in welding the cast iron parts of the German ships, and was developed by Mr. Joseph McAllister, of the New York Central R. R.

Another method which has a similarly basic theory, and is especially useful for sections that are too thin to stud, that is, automobile cylinders, jackets, crank cases, heating boilers and other cast iron parts complicated in shape, and where no deformation can be allowed, is to run beads at right angles to the crack about eight to ten times the thickness of the weld at the crack, which right angle beads laced back and forth at intervals of four to six times the thickness of the piece hold the weld and adjoining cast iron from separating, so that the contraction takes place in the weld where it does no harm. Sometimes the weld will be stressed beyond its elastic limit and crack, but no precautions need be taken in welding, as this crack will then have steel to hold it. Naturally the less the heat used, the less will be the stress to be taken care of. To that end, use the light work taps on the machine to secure as little heat as possible, and proceed a little at a time, allowing the beads to completely cool before tackling the next one, except in the case of the beads at right angles to the weld, which beads should be put down as nearly as possible at the same time as the intermediate lengthwise of the crack beads. In pieces that have cracked and sprung apart and should be brought into alignment this method of cross-wise beading, proceeding from the smallest end of the crack, will bring the original pieces into such intimate contact that it is very often watertight before starting the intermediate beading. In order to keep the heat as low as possible our special electrode, whose melting rate is higher than ordinary steel, should be used. You will find this will aid materially in keeping the stresses down. All of this welding with steel is done without preheating or annealing of any kind, the finish if necessary being ground to size. In the case of a score inside of the cylinder wall, if the machine can be set at half-primary voltage so that it will draw an arc, but not sustain it, the metal can be deposited in one flash at a time using a special electrode without cracking the adjacent cast iron. In the case that the machine cannot be set at half voltage a foot switch in the secondary circuit or the primary circuit should be opened, as each drop is deposited so as to not use the high heat in depositing the metal. The finishing can then be obtained by grinding.

Notice has been filed of the organization of The American Welding Co., 24 Kenney Place, Newark, N. J. This company will operate a machine shop and welding works. The president of the new company is Mr. A. R. Walling.

DECARBONIZING AUTOMOBILE CYLINDERS

By B. Heyman

THE other day I happened to pick up a scrap from the advertising section of a well-known magazine and was attracted by the following:

"Every enthusiastic motorist enjoys the sharp, clear bark of a powerful, sweet-running motor. A hot spark in every cylinder! Valves opening wide and sealing tight! Just the right mixture from the carburetor! * * * If your motor seems to be losing its hill-climbing pep—if you have to work to get it started—if the compression seems to be getting weaker, there's a good chance that the trouble is due to carbonized valves. Carbon makes the valves stick, pits and burns them, causing them to leak, etc."

Yes, carbon is the little joy killer! It performs all the above mentioned evil functions. It also causes knocking in the cylinders, overheating, warped valve stems, leaky valves, etc. But the summation of all of these is simply the cause of one most important effect—loss of power.

Carbon is the direct result of improper combustion. For the complete combustion of any fuel there is a definite minimum quantity of oxygen required. This oxygen is generally supplied from the air. Limiting the air supply, so that the minimum quantity is not mixed with the fuel causes the formation of carbon. The black material which forms on lamp chimneys when the flame has been turned too high is generally labeled "smoke" or "soot." Actually, it is pure carbon. The sooty deposit which a candle leaves on a glass or metal plate held directly over the flame is also pure carbon.

In automobile engine cylinders, carbon is formed in several ways. Chiefly, it is due to the use of a mixture from the carburetor consisting of too high a proportion of gasoline. Such a "rich mixture" burns improperly when ignited by the spark, leaving a soft deposit of black material which collects on top of the piston and in the clearance space at the top of the cylinder. It enters every angle and pocket in the top of the cylinder, forming around the spark plug bushings, valves, etc.

If oil works up around the piston rings into the explosion chamber, it will burn, and, being unmixed with air (the supporter of combustion) will be only partially burned—incomplete combustion—resulting in carbon deposit. Such a condition would not ensue were enough air mixed with the gasoline, that is, if a lean mixture were used.

Generally, the first indications of such an accumulation in the cylinders appears in the form of "knocking." The continued piling up of layers of carbon, under the action of the high pressures and temperatures existing in the cylinder chamber, causes a hard scale to be formed. Occasionally the scale becomes hot enough at some point to ignite the fresh charge as it enters the cylinder. A premature explosion occurs. Its rapid repetition comes in the form of "knocking" which can hardly be overlooked.

As the carbon accumulates in every nook and crevice to which it can possibly find its way, some of it deposits on the lower part of the spark plugs. It short circuits the spark and prevents the formation of the spark at the proper point. "Missing" in any one cylinder readily identifies this condition.

Formations of the hard scale on the valves and valve seats, with frequent ignition of localized points, burns and pits the seats, producing leaky valves. Moreover, the deposit tends to hold the valves open at all times. The valve stems become heated and warp. Loss of compression is the result, and, of course, that means loss of power. An automobile run with such a state of affairs existing may be classed as a very inefficient piece of machinery.

Until recent years it was customary to remove carbon deposits by overhauling the motor and its parts, and scraping by hand. This method was very expensive, entailing as it did, the complete dismantling of the engine.

But the oxygen process has put into the hands of all automobile owners a simple and convenient process whereby automobile engines can be kept, at all times, in the condition described in the opening paragragh.

The name by which the process is designated is "decarbonizing." It is by far the cheapest and most expedient way of removing carbon from the cylinders. And the process is performed without the slightest possible danger of injury to the cylinder or any of the engine parts.

The principle upon which decarbonizing is based is the simple chemical reaction which occurs when pure oxygen and carbon are brought into contact with each other under the influence of heat. Complete combustion results, and the carbon is consumed, so long as any of it remains for the oxygen to act upon.

A complete description of the detailed process is usually furnished by any of the manufacturers supplying the necessary apparatus. But it would be well to summarize the method. The oxygen is supplied in steel containers at very high pressure. A regulator is used to reduce this high pressure to the lower working pressure. The oxygen is passed from the regulator through a flexible rubber hose to a specially constructed torch consisting of a valve and annealed copper tube, by means of which the gas can be controlled in the form of a very fine jet.

It is necessary first to shut off the gasoline supply at the tank valve and then run the engine until all the gasoline remaining between the tank and engine has been exhausted. The spark plugs are removed and the engine and adjacent parts covered with sheet asbestos as a precautionary measure. Occasionally sparks alight on oil-soaked portions of the machine, producing a hazardous condition. Holes are punched in the sheet asbestos to allow introducing the blowpipe through the spark plug openings into the cylinders. The piston of the cylinder to be decarbonized must be brought to the highest point of travel with both valves closed.

Regulation of the oxygen pressure, although differing somewhat for different types of apparatus, really has no effect on the result. The volume of oxygen supplied should not be excessive so that the reaction will be too rapid and still it should be at a rate which will produce the greatest economy as regards time and material used.

A small quantity of oxygen is introduced into the cylinder through the spark plug opening by placing the torch tube at the opening and cracking open the valve of the torch for a short time. Then a lighted match is dropped into the cylinder. A bright glow will be noted as the match burns in the pure oxygen that has been passed into the cylinder. The oxygen jet should then be applied at the cylinder opening. A crackling noise will follow and particles of glowing carbon will be blown out. The oxygen should be directed into every section of the chamber until all of the carbon has been consumed. Moving the stream around hastens the reaction and insures complete removal of the deposit. If, for any reason,

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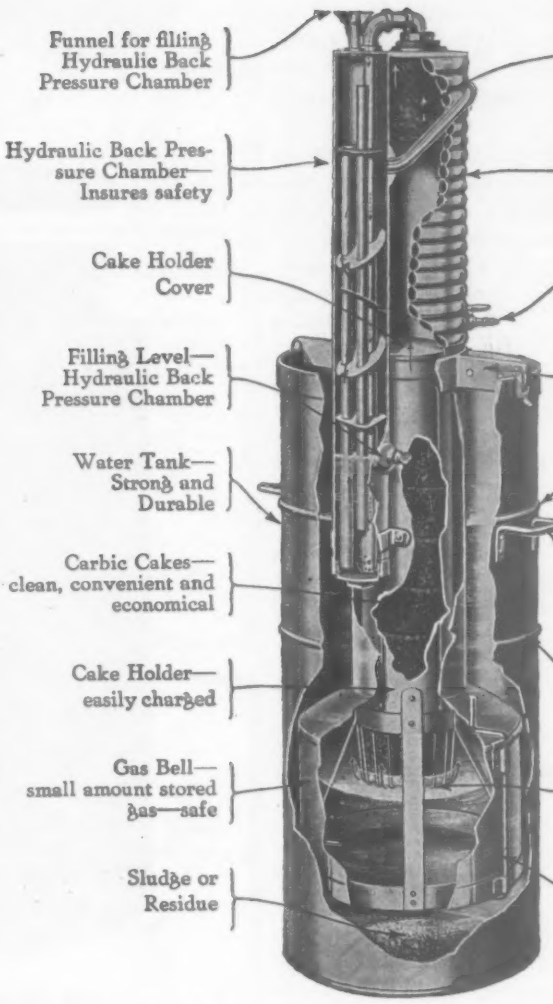
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the process is interrupted, although carbon still remains, the reaction can again be started by the aid of a lighted match. After all of the deposit has been removed the glowing ceases, and the torch valve is closed.

The remaining cylinders are cleaned in the same manner. It is necessary in each case to place the piston at the top of its stroke with both valves closed.

Some operators prefer injecting a small quantity of kerosene oil into the cylinder and igniting it before applying the oxygen jet. Too much kerosene must not be used because of the sudden burst of flame that may result.

The spark plugs should be thoroughly cleaned before screwing back into the bushings. When starting up the engine after such a cleaning, it is advisable to run for a few moments with the exhaust wide open in order to blow out any particles that may have been left in the cylinder.

A word or two may be said of the gas used in the process. Oxygen is compressed into 100 and 200 cubic foot steel containers at a pressure of 1,800 pounds per square inch. Generally the full cylinder pressure reads about 2,100 pounds per square inch. Since the gas follows very closely certain well-known gas laws it affords an easy way to calculate the gas consumption on work performed. The temperature also has an effect, but this is so slight that it can be disregarded.

When the process is started the reading of the high-pressure gauge of the regulator should be noted. When finished the reading should again be taken. Subtracting one from the other and dividing by 9 for a 200 cubic foot cylinder or 18 for a 100 foot cylinder gives the number of cubic feet used for the work.

Suppose the initial reading to be 1,750 pounds per square inch and the final reading to be 1,625 pounds per square inch. For a 200 cubic foot cylinder the gas consumption would be:

$$\frac{1{,}750-1{,}625}{9}=\frac{125}{9}=13.9 \text{ cubic feet,}$$

and for a 100 cubic foot cylinder the gas consumption would be:

$$\frac{1{,}750-1{,}625}{18}=\frac{125}{18}=6.95 \text{ cubic feet}$$

A rough estimate of the capacity of a 100 cubic foot cylinder would be about nine four-cylinder automobiles, but the figure is only an approximation and depends upon the condition of the cylinders and the skill of the operator. The time required is also a variable depending upon the above-mentioned factors.

WELDERS' PORTABLE SAND BLAST

In both electric arc and oxy-acetylene welding it is important that the parts to be welded be thoroughly cleaned before the welding operation is started. All rust, scale, oil, sand, et cetera should be carefully removed. It is also necessary to remove the scale and oxide from the deposited metal from time to time as the weld progresses so as to avoid slag inclusions between the several layers.

This cleaning work has generally been accomplished by a cold chisel, hand pick, roughing tool or wire brush. Such tools are not entirely satisfactory, however, because of the time required and because it is practically impossible to remove all dirt, scale et cetera by their use. This is especially true of the wire brush which polishes the scale on a weld, but does not remove it.

To fill the need for an efficient tool with which to do this cleaning work quickly and effectively, the Portable Sand Blast shown by the illustration, has been placed on the market by the Transportation Engineering Corporation, of New York and Chicago.

The Sand Blast consists of a heavy sheet metal tank of about four quart capacity, provided with a filling hole and an air-operated syphon. The syphon consists of a sand pipe, extending to the bottom of the tank, a pipe tee, an air nozzle and a sand nozzle. The sand nozzle is case hardened and is

New Portable Sand Blast.

provided with a renewable tip. A trigger valve is provided, as shown, for controlling the blast of sand. An air hose with a ⅜-inch nipple is attached to the open end of the valve, after which the sand blast is ready for use. An air pressure of from 75 to 100 pounds is required for the most efficient operation of this device.

It is claimed that the Sand Blast will quickly and effectively clean the parts to be welded and also the weld itself, and that it will do this work considerably faster and more thoroughly than is possible by any other means.

NEW SPOT WELDER

A new spot-welding machine has recently been announced by the Taylor Welder Co., of Warren, Ohio. The new model embodies features that make for easier operation than is secured in the older models, as the height and position of the hand lever can be changed to suit the operator. The machine is designed for handling work from 1/64- to ¼-inch thick.

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JERRY AND JIM

By Weldon

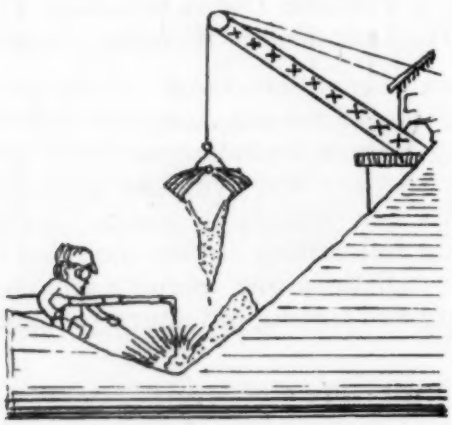
Brag is Jerry's middle name, otherwise he is a purty good fellow. He admits of bein' some wonderful welder and maybe there is some cutters around, but they will have to go some to beat Jerry when he is willin' to tell about it and it can't be said that Jerry isn't willin'. He don't claim to be a M. D., that's about all he don't claim, too, but L. A. fits fine behind Jerry's name.

Lingo Artists is some class all right and when you happen

Jerry and His Torch.

to split words with a L. A. welder then you sure will have to step some. He is there with the lingo all the time and, oh, boy, what he done and did and does is some little story that beats any Who's Who and other little story books what takes imagination and sand to write up.

Jimmy is just a plain ordinary S. W. He must of went to some such like as the Kodakchester School of manly arts where they learn them weldin' and opticmistics. Well, Jimmy



"Fluxin Chucked in with a Derrick."

is Some Welder all right. He ain't got the gaff, but he has got a lot of do. Jimmy's kind is kinder scarce, but them is the fellows what get the work out and it ain't no talk featin' about it neither.

Jimmy don't say much and most the time he don't say nothin' just pluggin' away and laffin' up his jumper when Jerry yarns about all he done before Noah was afloatin' the mountains.

The other day when they was fillin' up the bread baskets Jerry up and went tellin' about when he welded a twenty-foot cylinder what was cracked all the way round, crossways, crissways and other ways. To go by what he said it musta been a million feet of weldin' and hot, oh, baby, the horse hoofer hasn't anythin' on Jerry's preheatin'. A hundred bushels of charcoal and a hundred pound blast and asbestos by the truck load and tons and tons of cast iron sticks and fluxin' chucked in with a derrick. Yes, sir, he welded and he welded, sweatin' all the while like a Niagara. It sure was some job hearin' him tellin' it.

It took him two days settin' up. He had it all figgered out to a thirty-second and believe him it couldn't nobody have figgered that out but Jerry. And he built a furnis that was a marcellin' thing and then he gave it to'er and she was a blazin' away for a week.

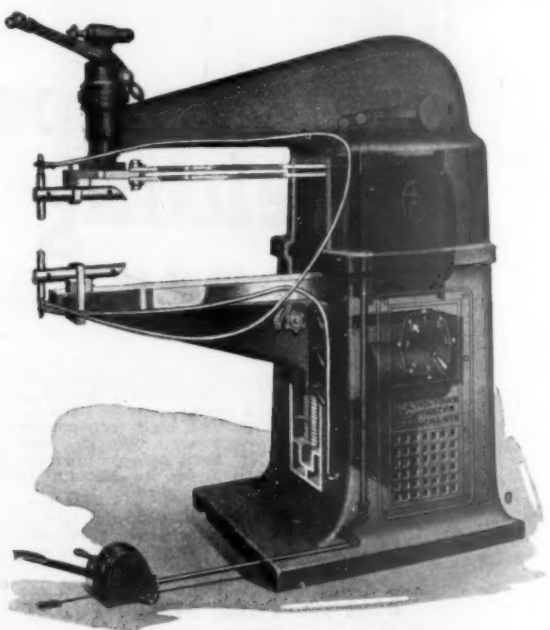
Jerry had a weldin' torch that he had build all hisself and it was some torch, let me tell you. Seven foot long from one end to another, four-way valves and a tip what was a foot and a half long and had a half-inch hole in it. You never heard of such a blaze, three inches long if anythin' and the gages all clamped tight. Pressur,e my body, the needle kept a jumpin' round a hundred all the time, says Jerry.

That was seven years ago when Jerry was a workin' in the South, Jerry said, and they took a picture from it and put a frame on it and all the papers had it and everybody said it was the biggest job anybody ever seen.

And poor Jim, the unappreciatin' fool like he is, chewed and chewed and only said: "They ain't never was such an animal."

NEW COMPANY TO MAKE RESISTANCE WELDERS

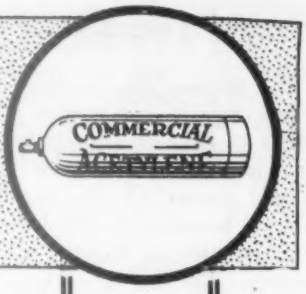
The American Electric Fusion Corporation has been organized at Chicago, Illinois, for the purpose of manufacturing a new line of electric resistance welding machines. The president of the new company is Mr. Edmund J. Henke, who has been associated with the Thomson Electric Welder Co. and the Federal Electric Welder Co., as chief engineer. Mr. Henke is a charter member of the American Welding Society, and is one of America's foremost authorities on the subject of



One of the New Spot Welders.

electric resistance welding. Mr. Edgar Littman is vice-president of the company, and Mr. S. G. Taylor, Jr., is secretary-treasurer. The director of sales, Mr. Arthur B. Sonneborn, has been associated with the Detroit Electric Welder Co. and with the Federal Machine & Welder Co. Temporary offices and works are located at 1906 N. Halsted St., Chicago, Ill. The accompanying photograph shows one of the new spot welders. Details of its new construction features will be available very shortly.

Commercial Acetylene



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S E R V I C E ▫

IF you buy acetylene you should become familiar with the COMMERCIAL plan.

Buying the *Commercial* way means that you buy gas only—we loan you the cylinders. **You USE what's inside the cylinders, and that's all you pay for.** You can get your money's worth, too, for *Commercial* acetylene is uniformly pure—it makes sound welds. *Commercial* engineers and *Commercial* plants and warehouses are at your service in every section of the country.

Acetylene supplied in portable cylinders of the following sizes and capacities:

10" x 30" size - 125 cu. ft. capacity
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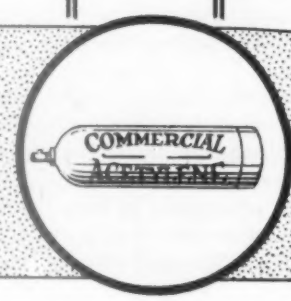
Submit your acetylene requirements to our nearest office.

Commercial Acetylene Supply Co.

Main Office: 80 Broadway, New York City
208 So. La Salle St., Chicago

Atlanta, Ga.	Aurora, Ill.	Boston, Mass.
East Deerfield, Mass.	Toronto, Ont.	Bound Brook, N. J.
Moberly, Mo.	W. Berkeley, Cal.	San Francisco, Calif.

Commercial Acetylene



TWENTY-THREE-MILE GAS-WELDED PIPE LINE

The Midway Gas Company, of Taft, Cal., has recently completed 23 miles of 10-inch gas trunk line from its Elk Hill Wells to connect with Bakersfield, paralleling its 6-inch line that has heretofore served the Bakersfield territory. The welded portion of this line, some 18½ miles, is of especial interest because of certain features of construction and handling employed to meet unusual conditions of terrain and climate. The line is practically a cross-country straight away, with very few bends, traversing open prairie and marsh lands at points miles away from even the crudest pretense of a highway. The temperature variations are always considerable during the day, ranging from sharp chill in the morning and evening to scorching heat at midday, modified at times by stiff winds that rise almost to the velocity of gales. It is obvious that the welders had to contend not only with the ordinary difficulties of contraction and expansion, but with operating obstacles of an unusual nature.

Ditch and Pipe Ready for Operations.

Each Crew Handled 20 Lengths.

Machine Ditcher at Work..

The work was carried on under the supervision of Mr. H. P. George, general superintendent of the Midway company, and Mr. J. W. Farner, foreman. Mr. C. R. Haynes was the head welder on the work. Eleven welding crews, composed of welder and helper, were stationed at successive stages of the work at such intervals that it was necessary to move camp but three times to complete the line. Oxygen and acetylene tanks were moved from one joint to the next on improvised sledges drawn by mules. The pipe and other material were shipped to the nearest railroad point and trucked from there to the work, horses being used whenever marsh lands had to be crossed.

The pipe, 10 inches inside diameter, weighing 27.37 pounds per linear foot, the sections averaging 35 feet in length, was delivered already beveled to 45 degrees at the ends, the bevels carrying through to the base or inside circumference of the tube. The ditch for the pipe was dug under contract with a machine ditcher, and was two feet in width and three feet deep.

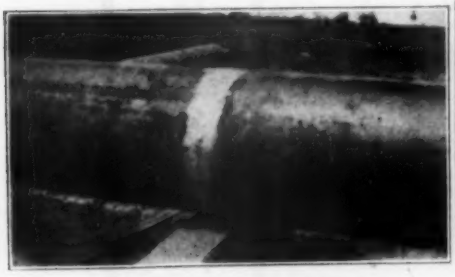
Twenty lengths of pipe were assigned as to the operating unit for each welding crew. The pipe was laid on the side of the ditch and rested on skids, the crews welding the joints successively, rolling the pipe into place and turning it as the work progressed to keep the work horizontal. When a series of twenty sections was welded, the completed work was rolled on the skids until directly over the trench and lined up with the preceding series by means of chains and tongs. If it was found the two 20-section lengths overlapped, the overlap was cut away and the abutting ends welded. In cases where there was a gap instead of an overlap, the space was filled by welding in a short section of the right length.

During the actual welding, expansion and contraction of the pipe, due to atmospheric changes, were ignored, excepting when tying in the 20-length sections. The welding of the latter was always done in the cool of the morning to avoid any possibility of contractional ruptures. This was necessary, because, while expansion would take care of itself in effecting slight undulations in the line, without this provision for uptake, contraction tension might result in a break where, as in this case, the extreme variations in section lengths at different hours of the day sometimes amounted to as much as six or eight inches. For this reason also the pipe was lowered into the ditch only at the coldest periods of the day.

After three or four miles of pipe had been welded, painted and lowered in the ditch, a temporary tie-in to the parallel 6-inch line was made and pressure put on to the pipe line for leaks. The end of the line was blanked off, either by welding a cap over it and later cutting it off, or by clamping with a reinforced blind flange, the latter being done only where the pressures were comparatively low. In this connection it is regarded as a fitting commentary on the general efficiency of oxy-acetylene welding as now developed, that there were but three or four defective welds that had to be repaired with the torch in the entire 18½ miles aggregating some 2,950 welds—approximately one to every thousand welds. The ratio of pinholes was less than one to every hundred welds, and these were easily closed with a punch.

In the entire line there was but one turn of 90 degrees, and this was accomplished by two mitre welds of 45 degrees each, placed about four or five feet apart. Near this bend was installed an 18-inch expansion sleeve. There were but five expansion sleeves in the entire 18½ miles. The engineers depended primarily on the uniform temperature of the flowing gas to counteract the slight contraction and expansion that would occur in the pipe after finally in place under the ground with gas feeding through it. It has been found that the variations of temperature under operating conditions are very slight in this part of the country compared to those which the work is exposed in construction. One drip pot was installed, and was designed by the Midway engineers.

This line is for the purpose of conveying gas from the Elk



One of the Welded Joints.

The 90° Turn.

Operator Making Butt Weld.

Hill Wells, near Taft, to the Kern River oil fields in the Bakersfield country. The gas leaves the wells under a pressure of about 350 pounds to the square inch, and reaches its destination at a pressure of from 75 to 150 pounds.

It was originally intended that the Midway line should be entirely of oxy-acetylene welded construction, but shortly after the work was begun it was found necessary to use about 4½ miles of second-hand pipe with screwed joints on the Elk Hill end of the line, diverting the pipe originally planned for this line to another line leading from Elk Hill toward Taft.** Definite data covering gas consumption are not at present available as part of the 7',400 feet of oxygen and 68,900 feet of acetylene delivered for the lines was converted to other uses. On the basis of deliveries, the consumptions would average 25.56 cubic feet of oxygen and 23.36 cnbic feet of acetylene per joint, or 9.53 cubic feet of oxygen and 8.71 cubic feet of acetylene per linear foot of welding—considerably higher than normal for welding ¼-inch steel; but these consumptions include oxygen and acetylene used in cutting. It is expected, however, that the corrected figures, when obtained, will be found somewhat above normal also, owing to adverse conditions of work in this particular field, where high winds retarded the welding much of the time and mosquitoes in the marshy stretches interfered with normal manipulation.

CAST IRON CUTTING

Gray cast iron cannot be cut by the oxy-acetylene torch with the same speed and freedom as wrought iron and steel. It is practical, however, to separate cast iron. The resulting cuts are somewhat wider than cuts in steel of the same thickness and the consumption of gases is more. However, for those cases requiring the separation of cast iron by the burning process the difference in cost is not usually of much importance.

Generally speaking, there is little need for cast iron cutting as compared with steel cutting. Castings are made in the foundry of the shape and size desired, and no commercial reason exists for cutting castings in general unless it be heavy sprues and gates. The jobs that turn up are generally of an emergency nature. It may be necessary to remove excess metal, say from a heavy electric turbo-generator base or to cut castings in a junk yard too heavy to break apart with the means at hand. Cast iron tanks used in some chemical works sometimes are re-bottomed and in this case the cutting torch is used advantageously to remove the old one. Drop forge concerns would find the cast iron cutting torch valuable for roughing out cast iron bolsters used with trimming dies. These bolsters are made in blank and the opening is machined to the shape required to match the die. Often the shape is irregular and costly to drill and slot. Hence, the desirability of using the cutting torch. In order to use the torch, some of the drop forge concerns order steel casting bolsters which can be cut with facility. Another use for the cast iron cutting torch sometimes felt is veeing heavy broken castings preparatory to welding, thus saving chipping or other mechanical removal of the metal.

An example of the value of cast iron cutting was afforded in a cast iron connecting rod for a huge metal drawing press. It became necessary to shorten the connecting rod by about 15 inches in order to afford space beneath the slide for a large die. This connecting rod was cut apart with cutting torches, the cross section being about 14 inches in diameter. After cutting apart and removing the section to be rejected the parts were set together leaving a space of about 2 inches, and welded with thermit. Thus, by the co-operation of two modern processes of separating and welding, a costly casting was saved.

The oxygen pressure recommended for cutting cast iron is about 125 pounds and the acetylene pressure 20 to 25 pounds. It is evident that only acetylene compressed in cylinders may be used in the present state of the art.—*Autogenous Welding.*

The expendients noted in the text, relating to provision for expansion and contraction in pipe lines, are comparatively recent engineering developments, but are not so new as to be regarded in any sense experimental. Indeed, there is not the slightest doubt that, had similar precautions been taken, some of the earlier difficulties encountered, notably in the mid-continent field, might have been effectually removed. This is indicated by the success of welded lines in Wyoming where even greater extremes of temperatures are experiencd.

MANY WELDING EXHIBITS AT RAILWAY APPLIANCE SHOW

At the National Railway Appliances Exhibition, held in the Chicago Coliseum, March 14th to 17th, many of the prominent manufacturers were represented by interesting exhibits.

The Air Reduction Sales Company showed the application of bonds to railroad rails and the cutting of rails with the oxy-acetylene torch.

The Page Steel & Wire Co. displayed the Armco line of welding rods and wire.

The Torchweld Equipment Co. displayed a complete line of welding and cutting apparatus and supplies.

The Hope Natural Gas Company demonstrated Butane gas in cutting torches and blowtorches.

The American Gas Accumulator Company displayed welding and cutting torches.

The Carbic Manufacturing Co. displayed Carbic cakes, generators, welding and cutting torches.

The Walter MacLeod Company displayed preheating equipment.

CANADIAN WELDING SOCIETY ELECTS OFFICERS

At the first annual meeting of the Canadian Welding Society held in Montreal, Que., on March 15, 1921, which was attended by between seventy-five and a hundred members, the following gentlemen were elected as officers for the first year:

President, W. H. Wood, Canadian manager, Commercial Acetylene Supply Co., Inc., Toronto, Ont.

First vice-president, Thomas Jones, works manager, Canadian Vickers, Ltd., Montreal, Que.

Second vice-president, H. E. Mussett, sales manager, Canada Carbide Co., Ltd., Montreal, Que.

Secretary-treasurer, A. N. Robinson, editor, "The Canadian Welding Journal," Toronto, Ont.

Directors: F. Borys, commercial manager, L'Air Liquide Society, Toronto, Ont.; R. H. Combs, general manager, Prest-O-Lite Co. of Canada, Ltd., Toronto, Ont.; F. C. Hamilton, vice-president, Canadian John Wood Manufacturing Co., Ltd., Toronto, Ont.; J. G. McCarty, Canadian manager, Metal & Thermit Corp., Toronto, Ont.; A. J. McDougall, vice-president, National Electro Products, Ltd., Toronto, Ont.; W. F. Thatcher, general manager, Dominion Oxygen Co., Ltd., Toronto, Ont.

BOILERMAKERS CANCEL CONVENTION DATE

The Executive Committee of the Master Boiler Makers' Association has decided to "call off" their convention for this year. This convention was to have been held at St. Louis, May 24th to 27th, 1921.

WHITNEY RESIGNS ADVERTISING POST

Frank C. Whitney, for eleven years with the Davis-Bournonville Company, Jersey City, as advertising manager, has resigned. He was also sales manager for six years, 1914-1920. Mr. Whitney's future plans have not been announced.

Smith's Line

Smith's Acetylene Generators

—are complete, economical plants that will generate acetylene right in your own shop, at about ⅓ of its cost in drums. Smith can furnish the size that just meets the size of your shop. Write for full information.

30 lb. Carbide Capacity

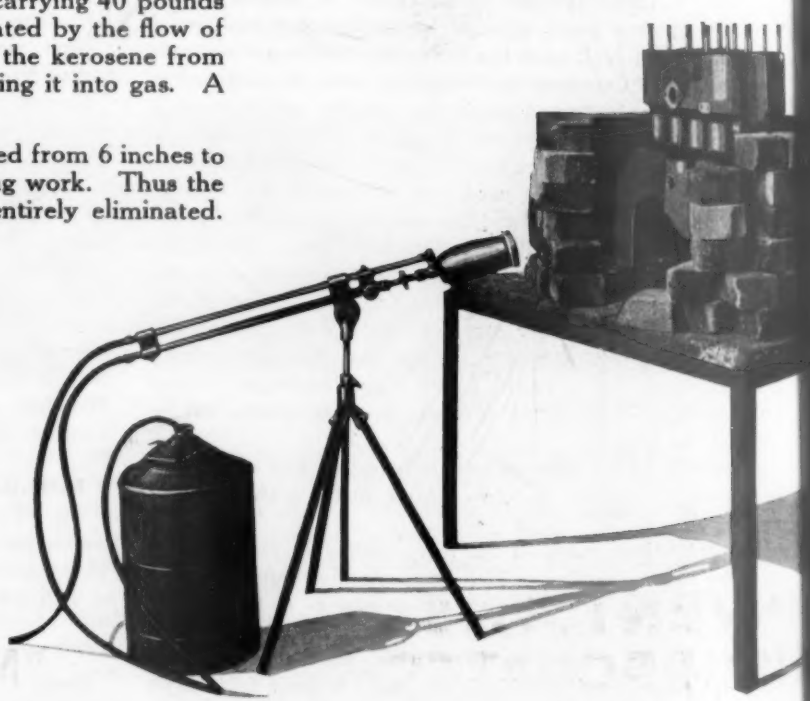
50 lb. Carbide Capacity

Smith's Pre-Heating Torch

This kerosene pre-heating torch is one of the greatest inventions ever offered to the welder.

The kerosene is not fed under pressure; and the torch does not have to be generated before it will light. Just drop the kerosene tube into an open vessel of kerosene and attach the air tube to any air line carrying 40 pounds pressure, or over. The vacuum created by the flow of air at the nozzle of the torch draws the kerosene from the vessel, at the same time converting it into gas. A match lights the torch instantly.

The flame of this torch can be adjusted from 6 inches to 6 feet, to take care of any pre-heating work. Thus the troublesome charcoal fires can be entirely eliminated.



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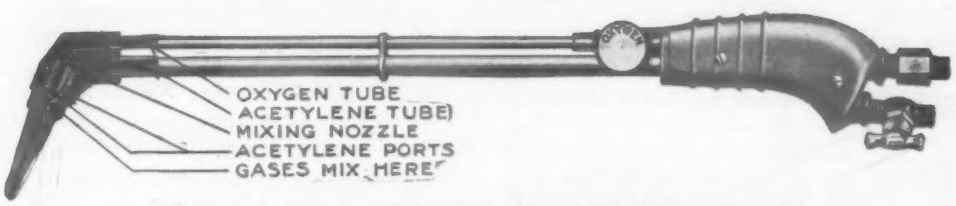
Welding Equipment

Smith's Welding Torches



(Cut-away view of Smith's No. 4 Welding Torch)

The exceptionally complete line of Smith's torches enables the welder to get the torch exactly suited to the work he has to do.

Smith has spent years studying the needs of the welding industry. The result is a line of torches immediately adaptable to all the needs in the welding trade. Whatever your line of work,—there is a Smith torch that will economically equip your shop.

In Smith torches there are distinctive patented features embodied in no other welding torches. The interchangeable welding and cutting tips,—the non-flashback features,—the ease of handling, and economical use of gas are features of every Smith torch.

Smith's Torches and Generators Have Been in Use Since 1906. Each Torch is Covered by Liberal Guarantee.

100 lb. Carbide Capacity

200 lb. Carbide Capacity

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Make big money repairing Scored Cylinders and Cracked Water Jackets by the **EVER STAY PROCESS.** We GIVE you complete instructions on making tools and applying **EVER STAY METAL** with an initial order of **EVER STAY METAL AND FLUX.**

EVER STAY METAL ..... $2.75 Per Pound
EVER STAY FLUX ..... 1.00 Per Bottle
EVER STAY SOD LOOM, for Aluminum ..... 2.75 Per Pound

This metal sold on a Money Back Guarantee. All orders shipped C. O. D. No orders shipped less than two pounds of metal.
Prices F. O. B. Omaha, Nebr. Jobbers wanted in every city.

Distributors for Rego Welding and Cutting Apparatus.

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Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

Wanted—Salesmen, Demonstrators, Welders and others meeting the welding trade to solicit subscriptions to *The Welding Engineer,* or furnish names of possible readers. When you put your friend or customer in touch with this publication you do him a real favor—make it possible for him to learn more about autogenous welding, liberal proposition. Write me now. Yours for welding, Mackenzie.

For Sale at Attractive Prices—Prest-O-Lite Service Agreement on 10-WK. cylinders. Address 42, care *The Welding Engineer.*

FLUX FORMULAS for Cast Iron, Brazing, Copper and Aluminum. We will mail the FOUR guaranteed formulas for $4.50. Write today. American Flux Co., Box 153, Madison Square Station, New York City.

Welders, Save Money

Make your own Cast Iron and Aluminum fluxes. Satisfaction guaranteed. These are the better kind. $4.00 for all three. Pacific Flux Co., 18 Natoma St., San Francisco, Calif.

For Sale—One 200-lb. Duplex Generator, one ten-cylinder Manifold, ten low pressure Welding Stations. Additional equipment to make installation complete. Manufactured by Oxweld Acetylene Company. This is new equipment, has never been installed. If interested write The Hoover Suction Sweeper Company, North Canton, Ohio. 2t-Mar.-Apr.

Position Wanted—Electric welder with five years experience on boiler and generator repair work. Prefer Chicago location, but willing to leave city if opportunity is a good one. Address Henry Thessenvitz, 1319 W. 14th Place, Chicago.

Wanted—Position as welding foreman. Gas and electric welder with 3 years' experience. Will take welding position that promises future. Now owner of shop. Address 61, care The Welding Engineer.

Position Wanted—By acetylene welder with 26 years' experience as boilermaker. Full knowledge of boiler and repair work. Sixteen years in last position. Address 62, care The Welding Engineer.

For Sale—1 Davis Bournonville large style C welding torch with 10 tips, 1 to 10, like new. Cost $70.00, want $50.00. M. A. Mueller, Muscoda, Wis.

For Sale—Oxweld low pressure generator in good condition. Address 63, care The Welding Engineer.

For Sale—One 500-lb. Oxweld generator, new. Never used. 25% below cost. Address 64, care The Welding Engineer.

Wanted—Oxy-Acetylene Welder for a small job shop doing all kinds of gas welding, located in southern town of ten thousand on the Atlantic coast. Must be first class welder, also something of a job shop machinist or blacksmith. Job permanent if you can deliver the goods. State age, salary expected, married or single. No booze fighters or windjammer wanted. Address 65, care The Welding Engineer.

Wanted—Experienced acetylene welder, who is thoroughly competent to handle all kinds of repair work and new tank work, made of sluet and plate. Only married man who wants permanent position considered. Address 66, care The Welding Engineer.

Wanted—Experienced aluminum welder, who is competent to organize a welding department and instruct new welders. Must be a high grade man in every respect. Address 67, care The Welding Engineer.

Wanted—To exchange 6 W. K. Prest-O-Lite cylinders for 6 No. 5 Searchlight. Address 68, care The Welding Engineer.

For Sale—1 Zeno Portable Electric Welding Equipment. 220 volts, 60 cycles, capacity 80-200 amps. Good working order. Price $300.00, F. O. B. St. Louis. Address 69, care The Welding Engineer.

Wanted—An experieiced all round acetylene welder. One who can weld all kinds of metal, aluminum, brass, steel, cast iron, etc. In reply state age, experience, etc. We pay good wages for good men. 510 E. Water St., Syracuse, N. Y.

Position Wanted—Electric Welder, with 14 years' experience, desires to locate as demonstrator or salesman. Any territory. Best references. Address 70, care The Welding Engineer.

For Sale—1200-300 lb. generator; 29 No. 2 tips; 2 No. 3 tops; 28 No. 4 tips; 36 torches; 40 single gauges; 38 double gauges; 1 box brass plugs. Prices reasonable. Albany Welding & Boiler Shop, 40 Madison Ave., Albany, N. Y.

Wanted to Buy—1 General Electric 200 amp., direct current welding outfit. Motor to be 3 phase, 60 cycles, 220 volts. Must be in first class condition. Address 71, care The Welding Engineer.

LIBERTY ALUMINUM SOLDER permanently repairs Crank Cases, Aluminum auto hoods, auto bodies, manifolds—in fact anything made of aluminum. Guaranteed to give satisfactory results. Laboratory test shows 12,000 pounds tensile strength. Price $2.00 the pound, 10 pounds or over $1.75. Shipment cash with order or C. O. D. except where satisfactory credit relations established.

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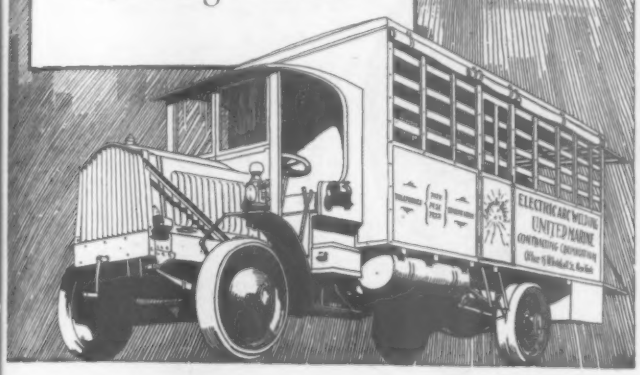

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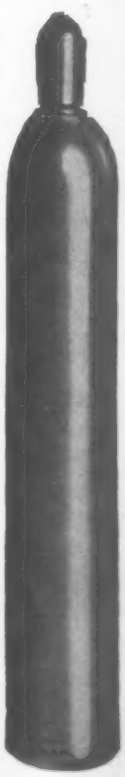
SEAMLESS STEEL CYLINDERS



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It Pays to Use Only the Best

Better, stronger and softer welds are more easily and more quickly made with Anti-Borax Welding Fluxes. That's real economy.

For Cast Iron, Brass, Bronze Malleable Iron, Steel, Cast and Sheet Aluminum

ANTI-BORAX FLUXES are scientific preparations which weld at lower head, leave no scale, cleanse the molten metal, assist fusion, prevent cooling cracks, and leave metal soft at welds.

Anti-Borax Fluxes are the best that money can buy, yet they cost no more—usually less than inferior brands.

GUARANTEED to give perfect satisfaction or your money refunded.

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ATTENTION, WELDERS!

Make big money repairing SCORED CYLINDERS by the LIBERTY PROCESS. Same pistons used. We sell the complete outfit including tools, and sufficient metal to pay initial investment and make a handsome profit besides. Full instructions for application included. Price $90.00 complete, cash with order or shipment via express C. O. D. Satisfaction guaranteed or money cheerfully refunded.

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You will also find the "WODACK" Portable Electric Drill equally handy in your repair shop.
Both tools are fitted with the "WODACK" universal motor and will operate on A. C. and D. C. current. *for des riptiveu*

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Proper protection for the welders' eyes has been given our undivided attention. Suffice to say we offer only the proven correct types.

Chicago Eye Shield Co.
2300 Warren Avenue
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CURRENT WELDING LITERATURE.

BRASS WELDING, by David Baxter,—The chief difference in welding different grades depends more upon constituents other than copper than on the shape of the article. Large copper content calls for larger flame. Hold cone at least a quarter-inch from metal, and at an angle with weld. Avoid oxidation of zinc. Cracks should be grooved before welding.—American Blacksmith, March.

EFFECT OF EXPANSION AND CONTRACTION IN THE OXY-ACETYLENE WELD, by N. Ward Guthrie.—Whenever the internal stress caused by contraction is greater than the tensile strength of the section a fracture is bound to result. In all cases wherever possible it is better to preheat. Spreading the edges by force instead of preheating is not advised. We cannot prevent expansion and contraction.—American Blacksmith, March.

WELDING WIRE ANALYZED—Booklet published by the Reid-Avery company of Philadelphia, containing the specifications of "Raco" welding wires. Gives analysis of eight grades of wire and describes their uses.

KEEPING THE TORCH BUSY, by David Baxter—Slack times present a problem for the welder as well as the business man. A good time to solicit business not otherwise sought. The torch operator need not be idle just because he has no welding to do. Other money-making jobs wait for him if he will only go after them.—Acetylene Journal, April.

OXY-ACETYLENE WELDING OF RAIL BONDS, by A. S. Kinsey.—Booklet issued by Air Reduction Sales Co., of New York. Describes the application of signal bonds to rails by the oxy-acetylene process. Data relating to the cost and efficiency of the oxy-acetylene welded bond as compared with the channel-pin method of connection are given.

GAS TORCH AND THERMIT WELDING, by Ethan Viall—A thorough discussion of gas torch and thermit welding practice and equipment. Details are given of the different makes of welding and cutting torches and how they are used. Preheating and actual welding practice are thoroughly treated. The composition of thermit, the making of molds and all of the details of practice are described. Published by McGraw-Hill Book Co., New York City. For sale by the Welding Engineer. Price, $4.00.

EYE PROTECTION— Catalog of Chicago Eye Shield Co. Fifty pages. Discusses effect of welding light on the eyes, illustrates and describes full line of spectacles, goggles, helmets, respirators, shades and shields.

THE TECHNICAL ENGINEER'S JUDGMENT OF THE OXY ACETYLENE PROCESS, by A. S. Kinsey—Booklet published by Air-Reduction Sales Co., New York. The mechanical engineer welcomed the process because it paved the way for welding a greater variety of metals. He had to give attention to new principles in shop practice. The efficiency of the process makes oxy-acetylene welding an engineering success.

TECOR SPECIALTIES—Catalog of electric arc welding accessories issued by Transportation Engineering Corporation, New York. Lists helmets, face shields, sand blasts, electrode holders, goggles and coated electrodes.

STANDARDIZATION IN THE TESTING OF WELDS—Standardization of tensile tests along new lines should utilize existing standards as far as possible. The bending test is of arbitrary character and therefore requires standardization. For fatigue tests the machine developed for the Welding Committee of the Emergency Fleet Corporation is recommended.—Acetylene and Welding Journal, London, March.

AUTOGENOUS WELDING OF ALUMINUM, by R. Granjon.—The author deplores the lack of progress made in welding aluminum, in view of the fact that the metal is being so widely used in all industries. It is only a question of keeping the metal at the joint at its original purity, he says, and giving the melted portions the correct mechanical properties.—Revue de la Soudure Autogene, February.

NEW ACETYLENE GENERATORS—Description of a new type of generator which employs both the water-to-carbide and carbide-to-water principles. The two principles can be used separately or together in this machine.—Journal de l'Acetlyene, March-April.

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Standard Carbide for Every Purpose

House Lighting Plants Welding—Brazing—Cutting

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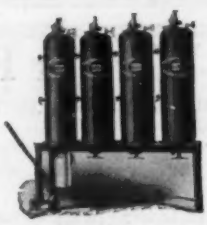

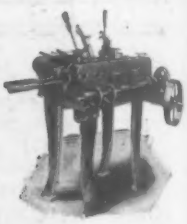

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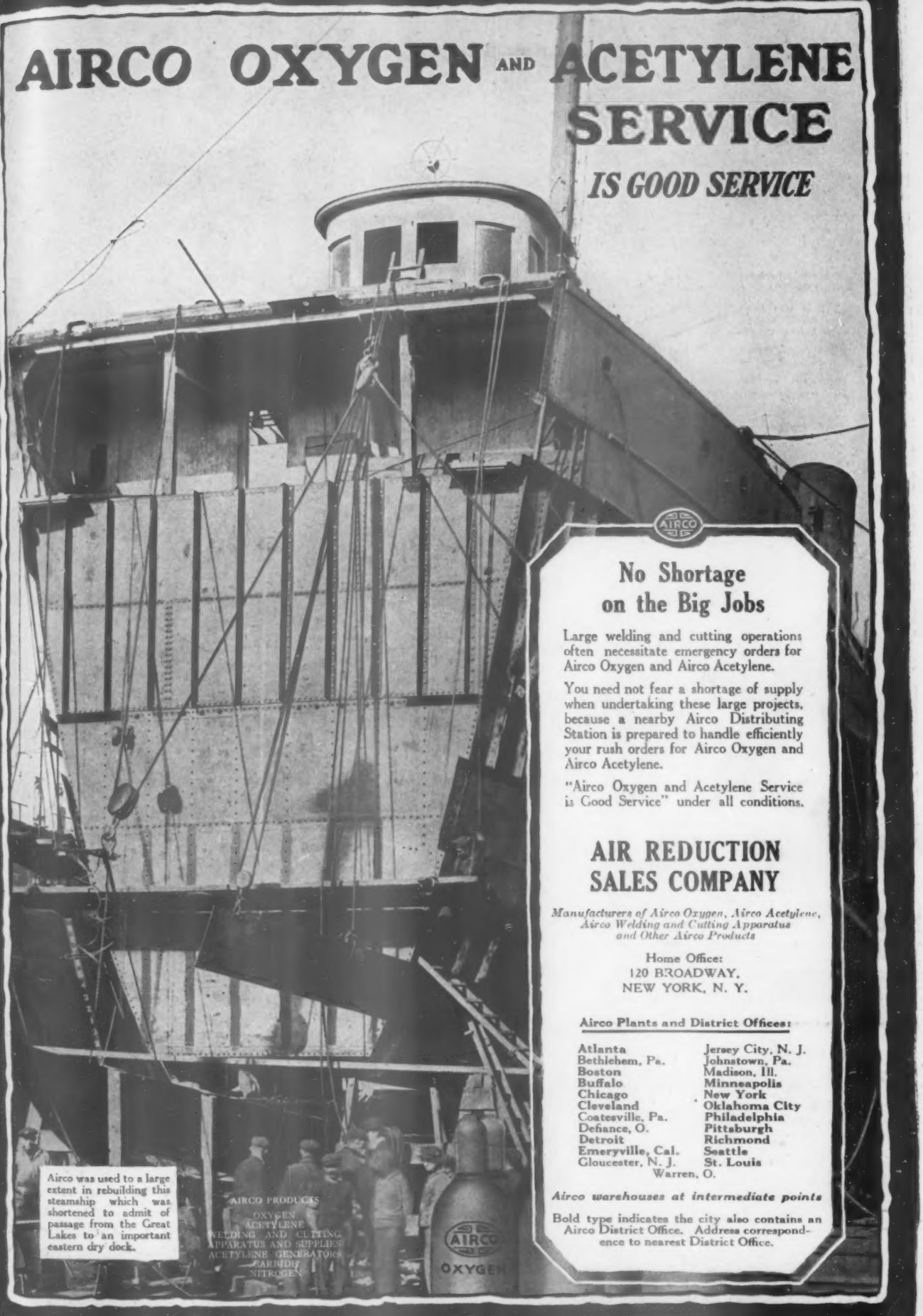

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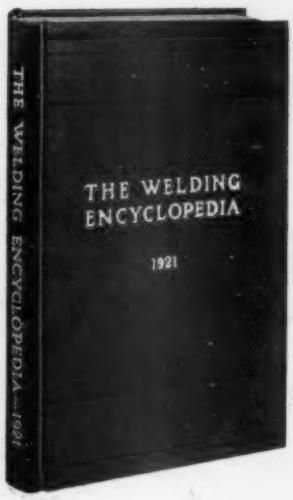

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